Radio, Electronics and Communications

FORMERLY "RADIO & ELECTRICAL REVIEW" — WIDELY KNOWN SINCE 1946 AS "R. & E."

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In This Issue . . .

PUBLISHED MONTHLY IN THE INTERESTS OF THE N.Z. ELECTRONICS INDUSTRY FOR ALL LEVELS, FROM PROFESSIONAL TO AMATEUR.

VOLUME 19 NUMBER 5

JULY 1, 1964

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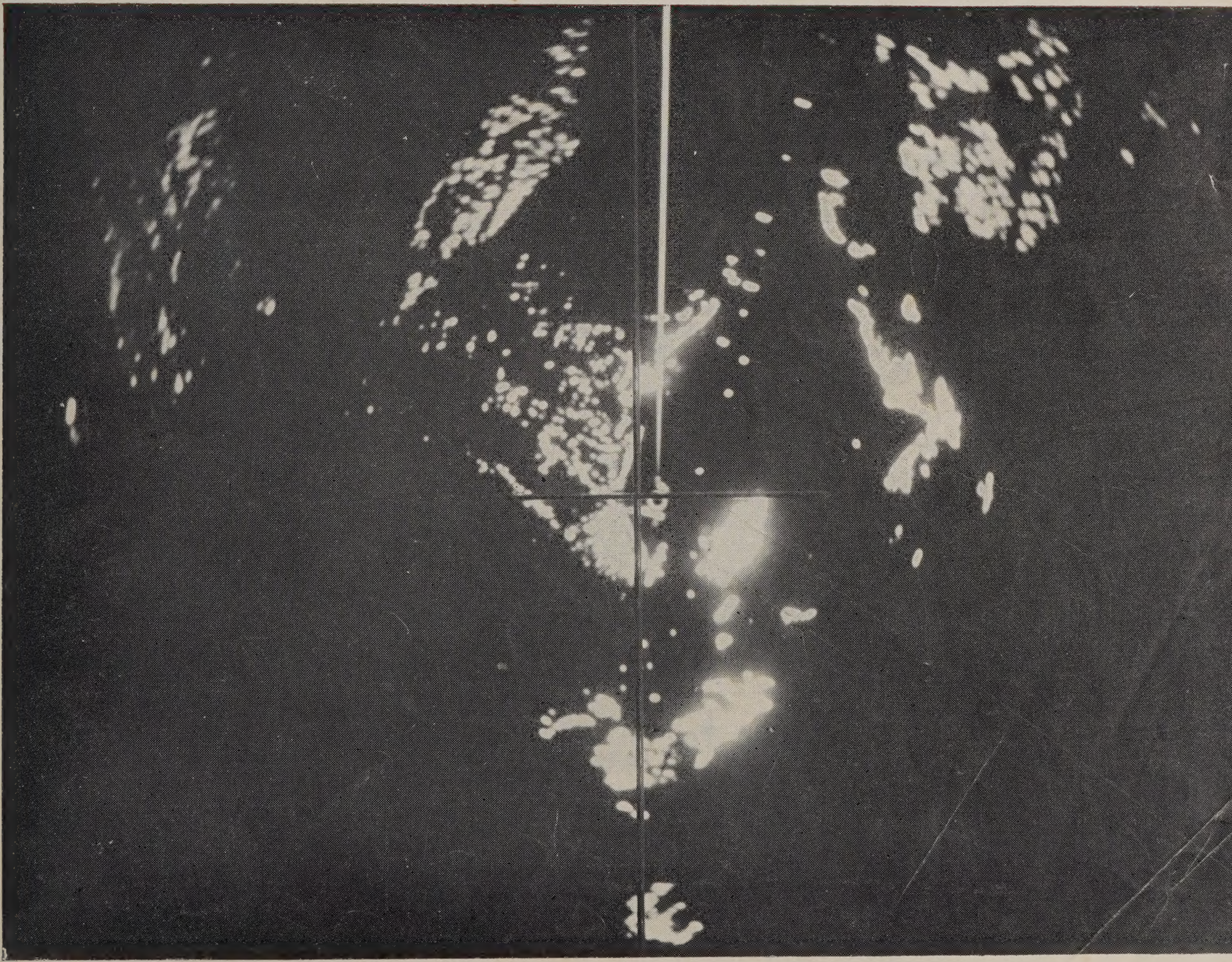

A Radar Picture of Whangarei Harbour from Marsden Point

AWA

AWA COMPLETE MAJOR COMMUNICATIONS CONTRACT FOR WHANGAREI'S NEW OIL REFINERY PORT —

See Page 3

Radio, Electronics and Communications

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Vol. 19, No. 5 July 1, 1964

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On Our Cover

A.W.A. COMPLETE MAJOR COMMUNICATIONS CONTRACT

The most comprehensive port communications and navigation system in New Zealand has been supplied and installed by Amalgamated Wireless (Australasia) N.Z. Limited at Whangarei. The system embraces base and maritime VHF and MF installations, tide recorders, aerial distribution networks, echo sounders, hydrographic survey equipment and radar.

A few years ago, only large ocean-going vessels were equipped with radar. The vessel on which this radar picture was taken is the Whangarei Harbour Board tug "Raumanga" which exemplifies the increasing use made of sophisticated navigational aids by small vessels. The Kelvin Hughes "Unit" radar system, chosen for its versatility, makes available a series of self-contained units which can be assembled in different ways to make up complete radar sets suitable for ships of all sizes and types.

FEATURED NEXT MONTH . . .

Making the Most of Technical Periodicals
A New High Efficiency 50 Kw M.F. Broadcasting Transmitter
Looking at the Future of Telecommunications
Some Aspects of V.H.F. Mobile Operation
An Unusual Grid Dip Oscillator

Also . .

New Products
Book Reviews
Serviceman's Column
Circuit and Service Data


MODEL 7000A
X-Y RECORDER
PEN SERVO
ON
OFF
GUARD
RANGE
MV/INCH
VOLTS/INCH
VAR
DC
AC
ZERO
INCHES OFFSET
SWEEP
SECONDS/INCH
TEST
START
CHART
POWER
HOLD

Letters from Readers

Sir,

Some months ago I noticed a letter in your column dealing with the publication of a circuit for a 6in. TV receiver using a VCR 97 C.R.T.

Could you please advise me when this circuit is to be published as I wish to construct it.

GRAHAM HOOK.

Sir,

Last January I was reading your magazine and in the Readers' letters something interested me and I quote the passage relating to a description of a 5in. TV set.

"We intend publishing such a set using modern components, etc., in our March or at the latest April issue."

Accordingly, I forwarded a year's subscription to your office just to make sure I received my copy at the earliest date.

I just have to hand the May issue and I notice that the next magazine in June still does not describe the 5in. TV set.

I am disappointed and I would like to know just when, or if, you do intend to print the article as was your original intention.

M. LUDWIG
ZL3BD

Hell and magazines, dear correspondents, are paved with good intentions. However, as originally promised, this construction feature will appear just as soon as there is space available and when the unexpected problems encountered during construction of the set have been overcome. We also assure you that magazines dealing with the set will be forwarded to you hot off the press.

—Ed.

Sir,

At the present time I am having difficulty in obtaining a circuit diagram of a radio receiver I own. Philips Mk. 11 Grand, Extended range. Model F.Z. 966A. Serial No. 93511.

From time to time I notice you publish circuit diagrams of various models of radio and television receivers in the Radio and Electrical Review. Quite possibly a circuit of the particular model I own has been printed in a previous issue of the Review.

I would be most grateful if you could advise:

(1) Whether you are able to supply me with the required circuit diagram and adjustment data of the model mentioned above;

(2) And advise the cost of same.

B. M. G. WHITE.

We have made inquiries concerning the circuit diagram you request and it shall be forwarded to you just as soon as it comes to hand.

—Ed.

Sir,

Could you please send by return if at all possible the following information:

In the back of your Review 1st February, 1964, you have a list of technical journals. Could you please inform me as to where I could get any of these.

BRIAN M. ZUPPICICH.

We have been advised by Technical Books Limited, Auckland, that their Wellington shop at 81 Ghuznee Street, Phone 51-137, will be happy to arrange subscriptions for any of the Technical Journals listed in Radio & Electrical Review. We understand that they also have on hand sample copies of these journals.

—Ed.

Subscription Concession Rate . . .

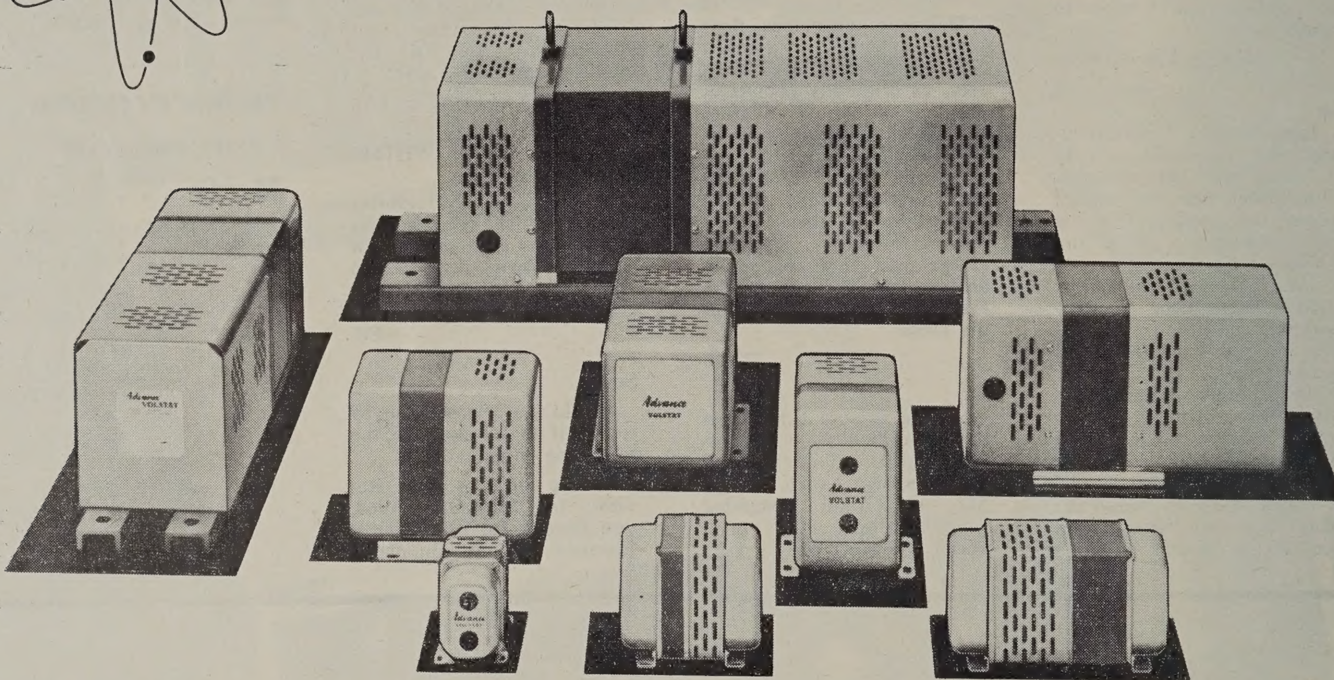
We have pleasure in announcing that we have introduced a new concession subscription rate for two-year subscriptions.

The rates are now:

12 months 30/-
24 months 50/-

Advance

VOLSTAT
CONSTANT VOLTAGE TRANSFORMERS



The VOLSTAT Constant Voltage Transformer is a static electro-magnetic voltage stabiliser and provides a most reliable and economic method of stabilising A.C. voltage supplies. It has many advantages over electro-mechanical devices, electronic stabilisers and ordinary magnetic stabilisers, some of which are:

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★ Small compact design — various forms of construction.

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FROM THE COMPREHENSIVE RANGE OF *Advance* **INSTRUMENTS AND EQUIPMENT**

What Is The State Of The Art?

New thinking in the communications field can often more accurately be described as putting to practical use the anomalies and unusual results which have been discovered in earlier years.

Some technical notes appearing in various overseas journals indicate that research is finding the present state of communications to be capable of considerable improvement.

The first item of interest is the prospect of using a new technique for long distance, high frequency radio communication. This has been brought to light by the three-year studies of a Standford University Research Engineer, Dr. R. B. Fenwick.

Dr. Fenwick has found that signals can be made to travel around the world along the underside of the ionosphere on what is termed R.T.W. (Round the World) paths.

Normal H.F. long-distance radio communication depends on bouncing the signals back and forth between the earth and the ionosphere in large hops, but under these conditions the signals are subject to many disturbing effects.

In the new system, two stations would, when the normal conditions fade out, change to RTW paths.

The use of the RTW path depends on finding a ''Tilt'' in the ionosphere near each station which correctly reflects the signal on its way, and then at the other end down to the receiver. These signal paths are quite practical as the ''tilts'' in the ionosphere occur daily and can be located by suitable ionosphere maps such as those produced by radio propagation laboratories.

This work has proved the importance of ionosphere to ionosphere reflections whose existence had been suspected but to a large measure ignored.

Although these reflections are available over a given path for a limited time—perhaps five or six hours each day—a number of improvements are possible. For example, higher frequencies than those predicted by conventional means may be used, thus making more channel space available in the long-distance H.F. spectrum. The transmission is less vulnerable to accidental or intentional interference along the ionosphere to ionosphere part of the path, and transmission can be more reliable over long distance paths.

As a direct contrast to these effects there is another technique which is being considered for practical communication circuits, that of underground communication. It has been suggested that practical ranges of some thousands of miles might be possible by making use of a high resistivity layer which is believed to exist under the ground in many parts of the world. This layer is thought to be sandwiched between highly conductive layers at the surface, and again at depths where high temperature conditions exist. This layer forms a natural underground waveguide.

A system using such a guide would have great practical significance, particularly in the military field. In a recent special issue of the I.E.E.E., ''Transactions on Antennas, and Propagation,'' devoted entirely to the subject, the various writers indicate that they hold out the hope of an extremely attractive Very Low Frequency signal path with effective shielding against natural and man-made noise and interference. Furthermore, they show the way to the first extensive and practical communication system for deeply submerged marine vehicles.

Not all the scientists agree that these layers will support signals for long-distance communication circuits, because of the likelihood of geological faults creating barriers similar to those of mountains and hills above ground. However, there is some experimental evidence to support the ideas and therefore sub-surface communication will be an important subject for further research.

Thus two of the present-day conceptions have become erroneous overnight, and the science of communications has advanced once more and will continue to advance for as long as men are capable of investigating the unknown.

—I.H.S.

LOOKING AT

AUDIO AMPLIFIER SPECIFICATIONS, CAPABILITIES AND MEASUREMENTS

PART II

Last month, we discussed the various types of defects which an audio amplifier can superimpose on signals which it is amplifying. This month we contemplate discussing some of the technical specifications with which we can assess the capability of an amplifier system, or use to compare directly one amplifier with another. To do this, however, we must keep our feet firmly on the ground and use only reproducable and sound technical tests, and not allow personal feelings or ideas to bias or prejudice the considerations.

To enable some logical basis for discussion, we will first introduce each particular topic by the relevant test specifications recommended by overseas authorities. We will then discuss these in the light of the various test procedures which have been adopted.

Performance standards require two things, measurement of the performance and a statement of the conditions under which the measurements were made.

Two overseas groups of manufacturers producing audio equipment have produced draft specifications for expressing the performance of audio amplifiers. These are the "Institute of High Fidelity Manufacturers Inc." of New York, and the Audio Manufacturers' Group of British Radio Equipment Manufacturers Association.

The first of these, in 1959, produced a specification entitled "The Institute of High Fidelity Manufacturers — Standard Methods of Measurement for Amplifiers." This specification, as the title implies, is concerned entirely with the standardisation of measurement methods and no attempt is made to indicate any particular minimum standard.

The specification produced by the British Radio Equipment Manufacturers Association was published in 1962 and is entitled "Specification for methods of measuring and expressing the performance of Audio Frequency Amplifiers." This document also deals with methods of measurement and ways of expressing the results.

A third specification is produced by the Professional Group on Audio of the Institute of Radio Engineers (now the I.E.E.E.) and is also widely used throughout the world as a basic reference for test procedures. It is interesting to note that there are relatively few major differences between these specifications, in many cases the differences being the result of a different approach to the same topic.

For instance, let us take the much discussed subject of the power output from an amplifier. The English group's specification uses the R.M.S. or continuous sine wave power output across the output load, as a basis, whilst the American Audio Group use what is commonly known as a Music-Power output rating. Practically, one of these results can be closely converted to the other in any case. Neither of the American or English Audio groups have included the measurement of transients using square waves or intermodulation distortion, due apparently to the feeling that methods for testing amplifiers for these characteristics has not yet advanced to the point where an acceptable method can be laid down.

At this juncture we intend to work through the specification for methods of measuring and expressing the performance of audio frequency amplifiers, published in April 1962 by the Audio Manufacturers Group of the British Radio Equipment Manufacturers' Association and take some of the more commonly used topics for discussion.

Shortage of space unfortunately dictates that we are not able to print the full specification which is several pages in length. It has been reprinted, however, in another Journal which has wide circulation in this country and reference is made to this journal in the list to be found at the end of this article.

Parameters

In most of the specifications which follow, the clause: "The Amplifier shall be operated under Standard Conditions of Measurement except as stated below" is used to simplify the discussion.

A summary of these conditions of measurement are as follows:

1. "Supplies for Mains operated

Amplifiers shall be within ± 2% of the rated voltage, except where a range of supply voltage is quoted in which case the average (arithmetic mean) shall be used.''

2. ''**Input and Output Terminations**: The input terminals shall be fed from a source impedance of 10,000 ohms unless other value is specified by the manufacturer, when, of course, this value should be used. The output terminals of the power amplifier section should be terminated in a non-inductive load, the value of which should lie within ± 5% of the stated value for the output load, whether or not it forms part of the measuring equipment.''

''**Measuring Signal**: Unless otherwise specified, the signal should be a sinewave, of 1,000 c/s ± 2% and the R.M.S. total of all components other than the fundamental (distortion products) should be less than 1/5 of the rated harmonic distortion of the amplifier at the particular level of measurement. If necessary a bandpass filter should be inserted to achieve this.''

''**Controls**: (a) Gain controls—all controls whose primary function is the adjustment of gain shall be set for maximum gain for the particular input in use unless it is necessary to take measurements at a reduced gain when the extent of the gain reduction shall be noted.''

(b) ''**Tone Controls**: Tone controls or filters whose primary function is the adjustment of frequency response shall be set or switched to the indicated flat response position.''

(c) ''Other controls such as loudness or presence controls which vary both gain and frequency response shall be set at the position of flattest frequency response.''

''**Special Notes with Reference to Stereophonic Amplifiers**: The balance control with stereophonic amplifiers shall be set at its indicated balance position. If separate gain controls are provided for the two channels they both shall be set for maximum gain for the particular input in use unless it is necessary to take measurements at a reduced gain when they shall both be tuned down to the same extent.''

Note: All measurements shall be taken separately for each of the channels in a stereophonic amplifier in turn.

''**Harmonic Distortion**: See our comments page 14 last month. Now the Definition states: ''Harmonic Distortion is that part of non-linearity distortion consisting of sinusoidal components whose frequencies are integral multiples of the frequency of the sinusiodal excitation.''

Method of Measurement: The specification states: ''The amplifier shall be operated under Standard conditions of measurement (see earlier) except as below.'' ''To ascertain the output voltage or power at which the Harmonic distortion becomes a specified value, a distortion percentage meter, which automatically sums the power in all the harmonics and gives the result as a percentage of output voltage or power may be used, with, if necessary, a high pass filter to remove any hum or power supply ripple products.''

''Where a single figure of harmonic distortion is quoted this shall be for a frequency of 1,000 c/s.''

''If it is desired to plot the characteristic curve for harmonic distortion, the amplitude of the input signal shall be adjusted so that the amplifier output is maintained at the level of the rated output voltage or power as appropriate (see later) whilst the frequency of the input signal is varied between the upper and lower limits where the measured harmonic distortion in the amplifier output is five times the value claimed by the manufacturer for a frequency of 1000 c/s.''

''Measurements shall be taken at sufficient intermediate frequencies, including 1,000 c/s, to enable the characteristic curve to be plotted using a logarithmic scale for frequency as the abscissa and a linear scale for the distortion as the ordinate.''

There is nothing particularly difficult about this part of the specification. The requirements are, of course, a suitable signal generator, with calibrated attenuator and band pass filter if necessary, a dummy load of the correct value and suitable dissapation ability and a distortion factor meter. Some manufactured amplifiers are capable of bettering a figure for total harmonic distortion of 1%, a few are quoted as capable of better than .1%. Note that the distortion figures produced by this specification are at rated output, not at some lesser figure of say 1 watt where the amplifier may be capable of 10 watts or more. Likewise, the specification does not demand the distortion figure at maximum output, because conversely the harmonic distortion figure is also used as a reference for the power output (see later).

Frequency Response Characteristic: See page 13 of last month's article for discussion on the effects of poor frequency response.

The Definition in the specification states: ''The Frequency response characteristic is the curve showing the variation of gain with frequency relative to the gain at 1,000 c/s.''

The method of Measurement is as follows:

''The amplifier shall be operated under Standard Conditions of Measurement (see earlier) except as stated below, and the results shall be graphed with the frequency as abscissa on a logarithmic scale and the variation of input voltage (in db) as the ordinate on an inverted linear scale with the input voltage at 1,000 c/s at 0 db.

(A) Pre-amplifiers (1) **The Level Response Condition**: ''With the amplitude of the input signal being adjusted so that the amplifier output is maintained at the level of half the rated output voltage, the frequency of the input signal shall be varied between the limits of half the minimum to twice the maximum of the range of frequencies over which the manufacturer claims a level response (i.e., within ± 1 db).

''Measurements of the input voltage shall be taken at sufficient intermediate frequencies, includ-

ing 1,000 c/s, to enable the characteristic curve to be plotted.

If these tests are made through part of the amplifier which has controls affecting the frequency response then these controls should, of course, be set at the level condition. Any filters conditions such as presence, rumble or loudness should be switched out.''

(2) ''**Gain Control Effects**: With all tone and filter controls set to their level position, the procedure above is repeated but with the input signal applied to the least sensitive input, and with the gain control set so as to give a reduction of output voltage to ¼ of the rated output voltage at 1,000 c/s.''

(3) ''**Bass Control Range**: With all other tone and filter controls set at the level position, the procedure in section 1, as above, is repeated with the bass control at both full 'boost' and full 'cut' positions.

(4) ''**Treble Control Range**: As for Bass control above.''

(5) ''**Filter Controls** — where fitted: As for Bass and Treble above.''

Power Amplifiers: The specification for test procedure states with the amplitude of input signal adjusted so that the amplifier output is maintained at the level of ¼ of the rated output power, the frequency of the input signal shall be varied between the limits of half the minimum to twice the maximum of the range of frequencies over which the manufacturer claims a level response (with ± 1 db). Measurements of the input voltage shall be taken at sufficient intermediate frequencies including 1,000 c/s to enable the curve to be plotted.

The procedure shall then be repeated, with the amplitude of the input signal being adjusted to maintain the full rated output power over either (a) the same frequency range or (b) between the frequency limits which require a 20 db increase in the input voltage over that needed to produce the rated output voltage at 1,000 c/s whichever is the smaller range.''

Integrated Amplifiers: ''With integrated amplifiers (i.e., those with preamp and power section combined in one unit) the method of test as outlined for Preamps shall be used but the value of the input signal shall be set to maintain an output level of firstly one quarter and secondly the full rated power output as outlined for Power Amplifiers above.''

Although time consuming, the tests as outlined above are not difficult to carry out. The equipment required is a suitable audio oscillator with calibrated attenuator, and an output voltmeter (a calibrated power output meter can be used with power or integrated amplifiers). When completed the curves can be compared against those prepared by the manufacturer, if these are supplied. If home-built equipment is being tested, then the appearance of the curve will indicate any major departure from the required response characteristics. Similarly, tone control performance figures can be assessed as can the performance of presence and rumble filters, etc.

The next section we will discuss is the one perhaps more often quoted (or misquoted) in discussions of amplifiers.

As mentioned earlier, there is a large number of kinds of ''output power watts'' quoted, and these stem from the use of some of the following terms applied in reference to output power capabilities. Some of these terms are: Sine-wave power (the one we will use); steady state power: music power (the one used by the I.H.F.M. as mentioned earlier); tone burst power; peak power, and instantaneous peak power. Some of these terms mean the same thing, although some give values twice as large as others.

The B.R.E.M.A. Specification for Rated Output Power of a Power or Integrated Amplifier is as follows:

''**Rated Output Power**:

Definition: The rated output power is the output power claimed by the manufacturer. It is determined by the power which the amplifier is capable of dissipating continuously in the stated load resistance, at a frequency of 1,000 c/s without exceeding the harmonic distortion claimed by the manufacturer.'' As mentioned earlier, the significance of this figure should be considered in conjunction with the harmonic distortion characteristics determined earlier in this article.

Method of Measurement: The specification states: ''The amplifier shall be operated under the standard conditions outlined earlier.''

To verify the rated output power, an input signal at a level to produce the claimed rated output power shall be applied to the amplifier for a period of not less than 30 seconds and the level of harmonic distortion shall then be measured (using the method outlined earlier and a distortion meter) to ensure that its value does not exceeed that claimed by the manufacturer.''

''If it is desired to measure the actual output power (which will usually differ from the rated output-power in that it will probably be higher), the input voltage to the amplifier shall be increased until the level of harmonic distortion claimed by the manufacturer (as measured using the method outlined earlier and a distortion meter) is produced along with the voltage across, or the power in the stated load resistance. The power in the load is then measured or calculated from the measurement of the voltage across the load resistance, and this power is the actual power output of the amplifier under test.''

It is also important to remember, in the case of stereo amplifiers, whether the power figures specified are for one channel or a total for both.

Turning briefly to the other methods of power measurement, we will discuss the ''music power'' measurement system. The American Institute of High Fidelity Manufacturers states in the ''Standard Method of Measurement of Amplifiers'' that sine-wave measurements (as we have detailed above) must be made with all significant supply voltages maintained at the same

please turn to page 18

A LOW DISTORTION AUDIO OSCILLATOR

Part II—

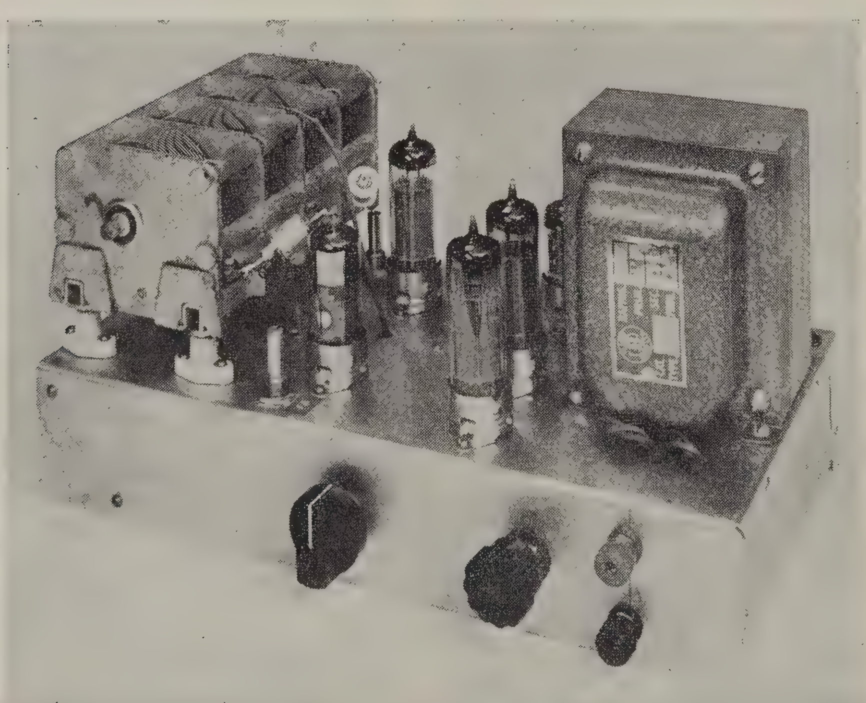
The Power Amplifier

Last month we described a variable frequency audio oscillator having low distortion figures suitable for a variety of audio work. As outlined, this oscillator was built up as a speaker test rig and this month we describe a conventional high-quality audio amplifier suitable for such purposes.

Oscillator Circuit

The basic circuit was described last month but we would draw readers' attention to two slight changes in circuit values. The resistor (350 ohms) in the EF80 cathode has been altered to a 500 ohm wirewound potentiometer labelled "Distortion." This has been suggested by the knowledge that some constructors have, or can gain access to, a harmonic distortion meter and so can adjust the instrument for minimum distortion. Our tests indicate that a value of 350 ohms will suit a variety of EF80 and EL84 combinations so that constructors without other test gear can set the control to this value.

The feedback control should be set so that oscillation is obtained with the minimum amount of control advanced. The easiest technique is to wind back the control until oscillation ceases and then advance it so that it recommences. Do this at several points on each range position. For reliable operation the control should be advanced about 10° or 15° above minimum oscillation position.



The Philips trimmers are used to obtain balance and scale "limitation" at the top end of the ranges. With this additional capacity slight unbalance in the wiring can be corrected. In addition, the "all out" capacity can be increased to limit the frequency ratio to, say, 10:1.

The cathode resistor in the cathode of the EL84 cathode follower has been increased to 330 ohms to improve the distortion by altering the grid voltage.

The Amplifier Circuit

The amplifier is a conventional Brimar ultra-linear circuit using a Beacon S81 "screen tapped" output transformer and will provide 8 watts RMS power with a distortion level under 2 per cent. From 200 c/s to 20 kc/s the distortion is 1.5 per cent. or less at 8 watts.

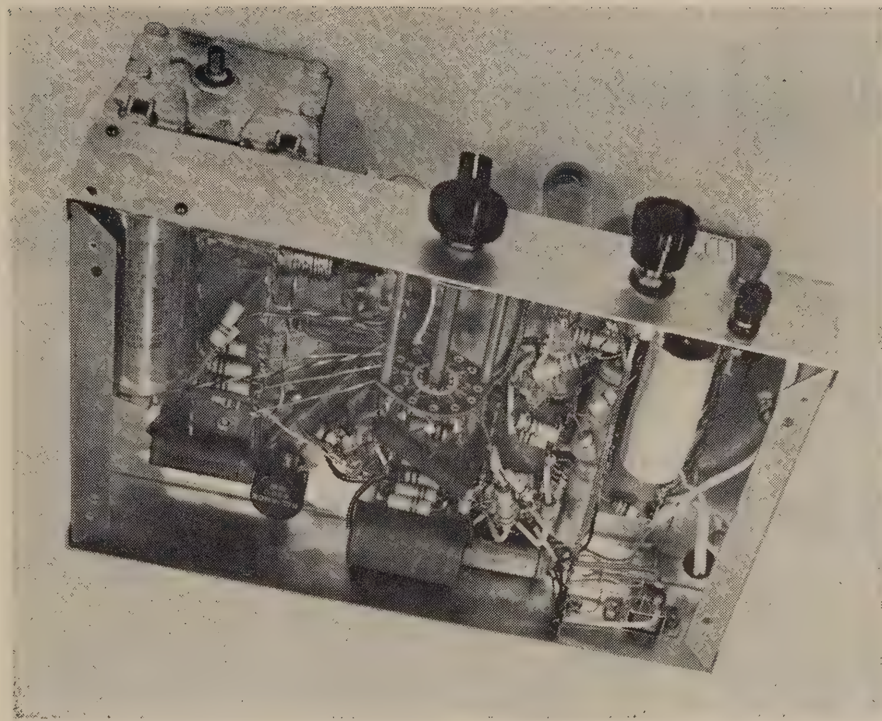
The circuit has no special features except that perhaps the feedback resistor is lower than in a conventional audio-amplifier. As the output from the oscillator was more than adequate gain reduction due to increased feedback could be tolerated to obtain good distortion figures. If other output transformers (or load impedances other than 16 ohms nominal) are used the value of the feedback resistor may need to be changed.

Using standard components it may be found that the drive to grids of the EL84 power amplifiers will be slightly unbalanced. To counter this it is suggested that the value of the 100K ohm resistor shown in the RH cathode circuit of the ECC83 be exactly determined by trial. An AC multimeter reading AC volts with a sensitivity of at least 1000 ohms per volt will be needed. A VTVM is the ideal instrument. When an AC voltmeter is used the load placed on the grid drive will be fairly high and an equal compensating resistor will need to be placed across the 470K ohm in the grid not under test. The compensating resistor will be

calculated from the known sensitivity of the meter and the range chosen (at least the 10 volt range).

Place the compensating resistor across the "lower" grid resistor and measure and note the drive voltage to the "top" EL84. Now place the compensating resistor on the "top" EL84 and place the voltmeter across the "lower" EL84 grid. Adjust the "100K" resistor to obtain the drive voltage noted above.

Randomly selected EL84's appear to match up fairly well but constructors may decide to obtain DC balance in the EL84 plate circuits by cathode bias adjustment. For this it is suggested that the EL84 cathode resistors be reduced to 220 ohm each and the "earthy" end of each connected to a 100 ohm WW potentiometer the variable arm of which is earthed.



Power Supply

The instrument described has been used off a separate power supply of commercial quality. It is not known how conventional supplies will affect performance. At worst the direct HT bar B+, A1 A in the circuit will need to be modified by decoupling. However, it is thought that this will not be necessary.

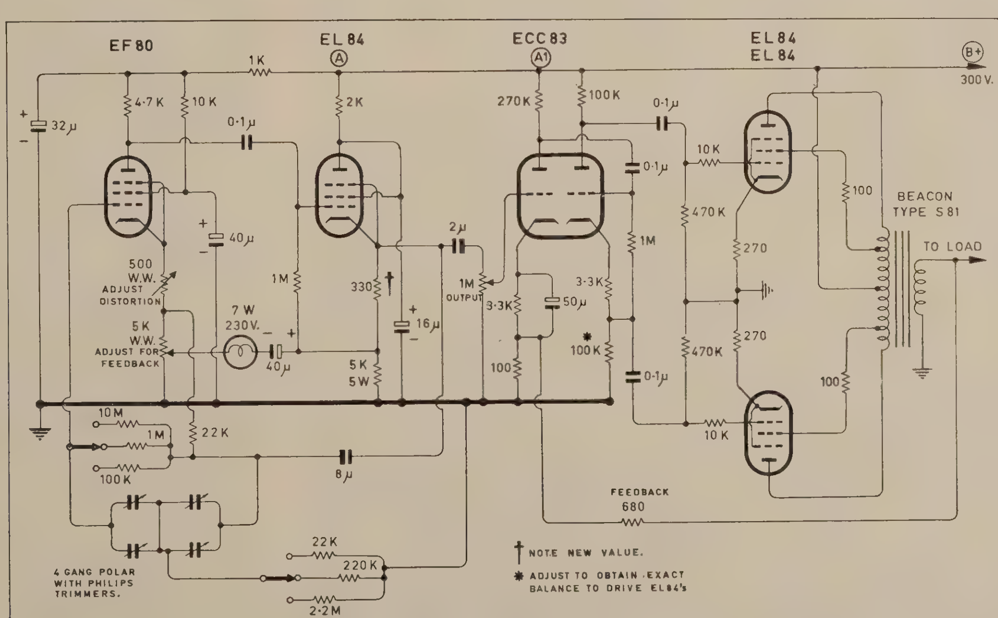
Metering

For accurate speaker impedance measurements of the voltage and current are required. It is hoped in a future issue to describe a simple "black box" for such purposes.

Distortion Figures

The total harmonic distortion at three frequencies and five power outputs are given below:

	100 c/s	1000 c/s	15 kc/s
1 watt	.28%	.18%	.22%
2 watt	.36%	.22%	.30%
4 watt	.8%	.5%	.68%
6 watt	1.3%	.9%	1.1%
8 watt	2.0%	1.2%	1.7%



colour television

This is a summary of a joint lecture given to the Auckland Branch of the New Zealand Electronics Institute on the 15th June by Mr. V. Baker, of Allied Industries, and Mr. J. Howe, of E.D.A.C.

Mr. Baker outlined the historical and commercial aspects of colour television together with details of personal experiences gained during a world trip last year.

Mr. Howe followed on with a discussion of various technical aspects involved in transmission and reception of colour television.

This is the first of many lectures which the N.Z.E.I. hopes to publish in this magazine in an endeavour to enable those who do not or cannot attend regular meetings to have the knowledge which is so ably offered. It will also allow members of the different branches to know more of the others' meetings.

By **PETER WATTS**

Introduction

Last year Mr. Baker visited those countries that were transmitting colour television and also had a look at some experimental work on colour TV that was being carried out in various countries. By talking to people who were using colour TV sets, seeing them in production, and listening to some of the comments from people undertaking experiments, the speaker was able to give the following overall impression.

Colour television is not new, in fact in 1928 Baird demonstrated low definition colour pictures as an extension of his black and white experiments, but it was not until 1951 that Columbia Broadcasting System commenced commercial transmission on 405 lines. This was not compatible and a C.B.S. type colour receiver would not reproduce normal monochrome transmissions.

Meanwhile, R.C.A. were working on a dot sequential system, which, although not entirely satisfactory, formed the basis of the current American system called N.T.S.C. after the National Television Systems Committee, that was set up to determine a suitable standard system for use in the U.S.A.

Transmission of colour pictures on the N.T.S.C. system commenced in 1954, and has gone ahead to the position where today, the United States has over 400 colour transmitters operating, and it is expected that sales of colour receivers will exceed one million this year (1964), rising to a probable two and a half million in 1967.

Quality of Colour Television

Mr. Baker felt the difference was like comparing black and white slides with projected colour transparencies and went on to say that there is no doubt colour television, being received as the designers of the equipment intended, is first class and brings a completely new medium of mass communications.

Cost of Colour Television

Currently, the cheaper colour receivers are selling in the United States for about 400 dollars, or about three times the price of a black and white set. There are no small sets or portables as yet, and there are still some technical difficulties in having a moveable set. This is due to the effect of the earth's magnetic field, and it is not advisable to move a colour receiver from its installed position. The cost of producing colour programmes is very high and because of this, the number of hours of colour transmission is limited, and a large proportion of the colour transmitters cannot originate their own programmes, but are tied to a network. Because the N.T.S.C. is a compatible system, monochrome transmissions can be received during periods when colour is not available.

Production of the picture tubes is quite a complicated procedure and requires a custom building process to ensure that the shadow masks line up accurately with the dots of coloured phosphors on the face of the picture tube; and it is to a large extent the cost of the picture tube that makes the colour receiver so much dearer than its black and white counterpart.

The production of the chassis and cabinetising, while a little more complicated, is down to a production system at R.C.A.'s plant, which was producing nearly 10,000 receivers a week last year.

Colour Television in Other Countries

Japan has a colour television service using the N.T.S.C. system, but they employ a smaller 16in. picture tube in most of their sets, and while Mr. Baker was impressed with the quality of products and components, and the production organization and efficiency, he did not see a good colour transmission. Most receivers he inspected did not seem to be capable of being adjusted to give the results seen in other countries.

The question of adjustment is one that calls for special mention. Most of the criticism of colour television in the United States is owing to the inability of the user to get a satisfactory colour hue and saturation balance, and if the three colours that make up the colour picture are not correctly balanced it gives pictures an unnatural effect, such as is seen with some of the less popular 35mm. colour films on the screen, or when films are exposed to incorrect colour temperatures.

In France, a system of colour transmission called S.E.C.A.M. is claimed to overcome the above problems, among other things, and for some three years British television engineers have been carrying out tests with a view to evaluating the advantages of S.E.C.A.M., and also a system making similar claims, called P.A.L., which was developed in Germany.

At a recent C.C.I.R. meeting in London, delegates failed to agree on a standard for colour television for Europe, and it would now appear that Great Britain will have to decide on the U.S. system of N.T.S.C., although S.E.C.A.M. has many followers.

Great Britain has reached a point where decisions on colour television have to be made if they are going to commence commercial colour television by 1966, and this is a date envisaged by some members of the industry. The B.B.C. are now carrying regular experimental transmissions of colour pictures and although most of those seen were slides, the speaker was impressed with the co-operation between the B.B.C. engineers and the development engineers at the commercial laboratories. The receivers he saw in England and Holland were not like the receivers in the United States. They were more like big commercial racks and looked most elaborate and expensive, but he believed two or three English manufacturers are well advanced with their plans to produce domestic colour receivers, even though there was no colour equipment demonstrated at the last Radio and Electronics Show at Earls Court.

Colour Television Servicing

This has had as much adverse publicity as did the service of black and white receivers when television commenced in New Zealand.

In the United States, R.C.A. have been one of the major manufacturers of colour receivers since colour started in 1954, and they have provided their own service for their sets in all areas. The records they have kept show that colour receivers require only slightly more service than a monochrome receiver.

Recently, some new manufacturers entered the colour picture tube business with 24in. 90 degree square tubes, and this has improved both the appearance and compactness of the receivers, although it raised the price by about 50 dollars.

Colour Television in New Zealand

In conclusion, Mr. Baker went on to say that he expects Australia to have colour transmissions within four years and predicts that New Zealand should have it about two years later, or about 1970, but pointed out that the big question is: Will our Government let us have it?

* * *

With the knowledge that colour television is not such a remote possibility here as is generally thought, we are certain many readers will find a summary of Mr. Howe's talk of great interest. Part of the evening was taken up in showing slides describing much of the equipment discussed and although it is not possible to present this side of the lecture here, it is hoped that the following will prove of definite value.

Fundamentals of Light.

It is generally known that light is an electromagnetic radiation, similar to radio waves but much higher on the frequency spectrum with wavelengths between 3800 and 7800 A° (Angstrom Units 10^{-10} meters) or 380 to 780 um. (Milli-microns 10^{-9} meters). The colour of light is dependent on the predominant wavelength. Each colour does not have a specific wavelength, but covers a narrow band of wavelengths with red occuring at about 6500 A°, green around 5500 A° and blue about 4500 A°.

Colour

A colour has three characteristics: brightness, hue and saturation. The first, brightness, is the already familiar component of monochrome reproductions used in black and white television and photography, whilst hue is dependent on the predominant wavelength, and saturation is a measure of the purity of the colour and is determined by the narrowness of the waveband. For example, red and pink have the same predominating wavelength and therefore the same hue. Red, however, has a greater saturation than pink.

For reproduction of colour the simplest case of three primary colours is used. In film processing, mixing dyes or paints, the three primaries red, yellow and blue are used in what is called a subtractive mixing system. This stems from the fact that the colour of an object appears to be a certain colour because it reflects that colour, and absorbs all the others. In this subtractive system it is theoretically possible to begin with white and subtract from this all the colours or pigments and eventually have black.

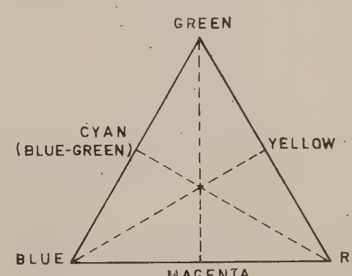


FIG.1 THE COLOUR TRIANGLE

On the other hand, coloured rays of light combine in what is known as an additive system.

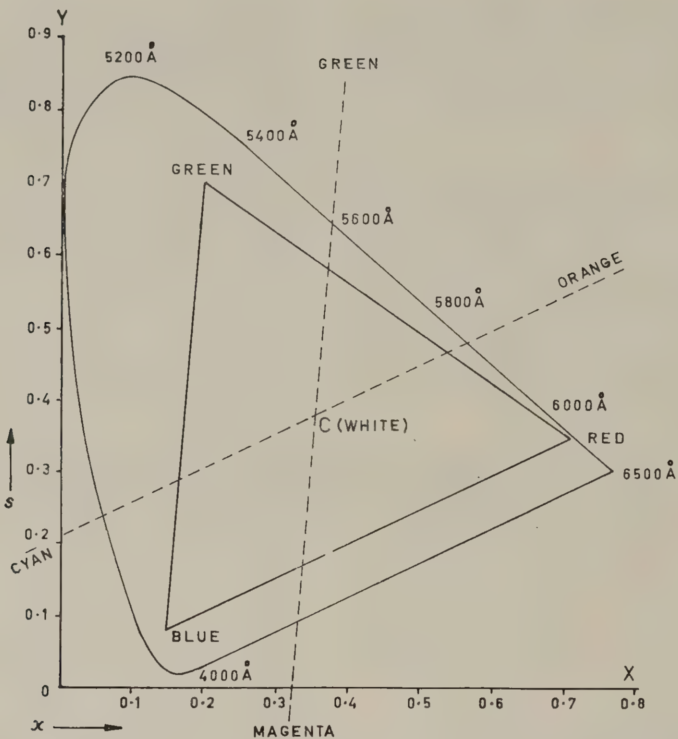


FIG. 2 SHOWS SPECTRUM LOCUS EMBRACING WHOLE RANGE

The three primaries in this case are red, green and blue and the units are selected on the basis that equal amounts of each produce white light.

This additive system is, of course, that which is used in all proposed colour television systems.

Colour Representation

It is possible to represent the additive system graphically, quite simply, by use of the Colour Triangle—an equilateral triangle in which the vertices represent the three primaries and each side the result of mixing the varying amounts of the colours at each end. This is shown in Fig. 1, where equal quantities of red, green and blue produce the complementaries cyan, magenta and yellow at the mid-points of opposite sides. The centre of gravity of the triangle, C, represents white, obtained by mixing any colour or complementary, or all three primaries, or all three complementaries in all cases in equal quantities.

The Colour Triangle is defective, however, in that spectral colours cannot be plotted within it, and Fig. 2 illustrates the Chromaticity Diagram, showing the spectrum locus embracing the whole range of colour occuring in nature, relative to arbitrary x, y axis. This diagram is derived from a spatial representation of a colour as a point in a two dimensional figure. The theory behind this is too complex for discussion here, however it may be taken that the spectral colours are represented on the horseshoe locus and that all colours may be represented within the curve. Once again point C represents white light and all points or co-ordinates near this tend towards white.

With reference to Fig. 2, it can be seen that colours R, G, B form a triangle corresponding to the F.C.C. standard colour television primaries which are used in a practical system. The colours outside this triangle are not really missed and a three colour television system proves quite adequate.

The Chromaticity Diagram therefore defines hue by angular direction, and saturation by distance from C.

Physical and Psychological Aspects

There are many different whites which may be considered in the Chromaticity Diagram, however the standard I.C.I. Illuminant C, derived from a combination of daylight and sunlight, is generally accepted.

In practice, there are many problems caused by illumination variations but adaptation of the eye compensates for these to a large extent. For instance, after viewing monochrome on a green phosphor cathode ray tube such as the VCR 97, the eye gradually adjusts to accept this as standard.

Also, the eye has a response to different wavelengths, as shown by the luminosity function of the eye in Fig. 3. Colours tending green and purple are seen in minimum detail (this permits transmission of these colours in a narrower bandwidth). The eye actually sees some colours as being brighter than others even when all are projected with equal energy.

Further, persistence of vision permits integration of colours sufficient to overcome the flicker effect, of which most readers will be aware through knowledge of motion films.

Colour Transmissions

A brief history of the development of the present-day systems is given in the first section of

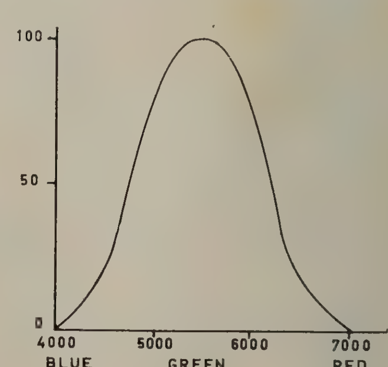


FIG. 3 LUMINOSITY FUNCTION OF THE HUMAN EYE.

this article and consideration will be given mainly to the operation of the N.T.S.C. system.

In colour television transmission it is necessary to transmit the three components previously mentioned, brightness, hue and saturation, and there are three basic means of doing this:

1. Separation in space—as in closed circuit television with three separate coaxial cables.
2. Separation in time—known as time sequential systems which eventuated Field, Line and Dot Sequential Systems.
3. By position in Frequency Spectrum — allowing simultaneous transmission.

N.T.S.C. System

Without going into the various pros and cons regarding choice of system it is sufficient to say that the N.T.S.C. System uses 3, in that it basically transmits brightness as the video waveform with colour information on a high frequency subcarrier as two chrominance components. In other words brightness and chromaticity are transmitted rather than primary colour components.

Luminance

The brightness information, or luminance signal, will require full video channel bandwidth identical to that used in monochrome transmissions at 5 Mc in a 625 line system. This means that the N.T.S.C. System is fully compatible and monochrome transmitting equipment will transmit colour, while colour signals produce perfectly satisfactory pictures on black and white receivers. The symbol for luminance is Y and with reference to Fig. 3, the luminosity function diagram, the following expression is obtained:

$$Y = 0.30\,R + 0.59\,G + 0.11\,B$$

Chromaticity

The chromaticity information or chrominance signals provide information on hue and saturation.

Since the eye has less resolution for chromaticity changes than for brightness changes, the chrominance signals can have a smaller bandwidth than the luminance signal.

The chrominance signals are termed I and Q, the In-Phase and Quadrature Signals, and the colour is therefore transmitted by varying the two chrominance signals, which are amplitude modulated and phase modulated, on a subcarrier at 90° as shown in Fig. 4. This is a basic representation of what is known as the Phasor Diagram. These signals effectively modulate two carriers of identical frequency, but differing in phase by 90°, which are then added to give the resultant subcarrier signal R.

The chromaticity is therefore given by the amplitude and phase of the subcarrier component (Resultant R) with the amplitude representing saturation, and the phase representing the hue of colour. The frequency of this subcarrier is near the limit of the video band and to avoid interference with the video signal must be an odd multiple of half the line scanning frequency and is chosen as 4.429687 Mc for 625 line systems.

The In-Phase signal, I, has a bandwidth of 1.5 Mc and is transmitted with unequal sidebands, whilst the Quadrature signal, Q, has bandwidth of 0.5 Mc and is double sideband.

This may be seen in Fig. 1 as dotted lines where the fullest use of the bandwidth is made by arranging the two chrominance components so that the Q signal conveys information relating only to colours lying along the green-magenta axis, and the I signal to those on the orange-cyan axis. Because of the reduced sensitivity of the eye to colours along the green-magenta axis, a narrower bandwidth can be used for the Q signal. By equating I and Q as below,

$$I = 0.60\,R - 0.28\,G - 0.32\,B$$
$$Q = 0.21\,R - 0.52\,G + 0.31\,B$$

it can be seen that absence of any colour, that is when $R = G = B$, I and Q reduce to zero producing white or grey, i.e., neutral colours occurring in many scenes.

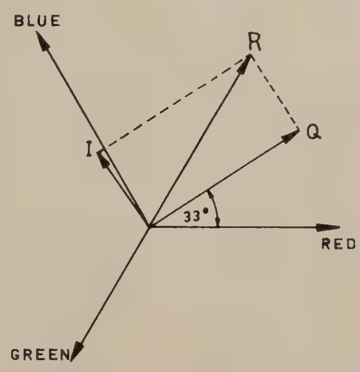


FIG.4 BASIC PHASOR DIAGRAM

The sound signals, as well as the luminance, are transmitted in the normal way, as in a black and white television system, by modulating the vision and sound carriers.

SECAM System

This system is similar to the N.T.S.C. in that it transmits a luminance and two chrominance signals, however only the luminance and one chrominance signal are transmitted at a time. That is, one chrominance signal alternates with the other on alternate lines. This necessitates use of a delay line and other costly components.

Also, the luminance signal is transmitted over the entire bandwidth of the video channel and the chrominance signal as a frequency modulation of a subcarrier.

P.A.L. System

The P.A.L. System is even closer to N.T.S.C. and differs mainly in that the phase of one of the two simultaneously transmitted chrominance signals is phase reversed by 180° on alternate lines. The receiver may or may not use a delay line to obtain cancellation of phase error.

The remainder of this lecture was taken up describing the equipment used, including vidicon and orthicon colour cameras, receivers, test equipment, and so on, and it is not possible to cover this in one article, however it is hoped that further articles describing some of the above in more detail will be published in the near future.

values as under 'no signal' conditions.

The Electronic Industries Association of the United States defines music-power output as a single-frequency power obtained at 5% total harmonic distortion or less when measured immediately after the sudden application of a signal and during a time interval so short that supply voltages within the amplifier have not changed from their no-signal values.

Both standards, in essence, have defined the same performance aspect of an amplifier, i.e., the power output at a given distortion level for signals of short duration as exist in music. The only significant difference is that the E.I.A. specifies a 5% distortion value, whereas the I.H.F.M. sets no such parameter; however, the I.H.F.M. do recommend that the distortion level at which the power output is measured is taken as the amount of total harmonic distortion as specified by the manufacturer. This rated distortion is usually of the order of ½ to 1%.

Where does the similarity between the English and the American methods lie? If we used a source of stabilised power supplies on the equipment undergoing the tests under the British system, so that the full signal voltage conditions remained the same as the no-signal condition, then the results obtained from the two methods should be in close agreement.

One important factor which should be investigated in amplifier systems is the matter of input-sensitivity. The B.R.E.M.A. specification on Sensitivity states: Definition: "The sensitivity of an amplifier shall mean the input voltage level in millivolts or volts which when applied to the input terminals of an amplifier operating under standard conditions of measurement will develop the rated power output across the load of a power or integrated amplifier."

The method of measurement is simply as follows: "The amplifier shall be operated under standard conditions and to each input in turn an input signal is applied, and adjusted, to develop rated output power; the voltage of this signal is the sensitivity for that particular input.

Two other factors which are sometimes not discussed in amplifier specifications but which are quite important are Damping Factor and Stability. The B.R.E.M.A. specification for Damping Factor is as follows:

"Damping Factor is the ratio of the rated load impedance to the Internal impedance of the amplifier." The method of measurement is set out as follows: "The Amplifier shall be operated under the Standard Conditions of measurement except as below, and a 50 c/s signal of amplitude to produce one quarter of the rated output power in the rated load shall be applied at the input.

The voltage across the output shall be measured and recorded as V2 then without adjusting the input the load is removed and the open circuit output voltage shall be measured and recorded as V1. The Damping factor is calculated from the formula

$$DF = \frac{V2}{V1 - V2} \quad ."$$

Since the source and load resistance are effectively in series, there is little to be gained in obtaining a damping factor greater than 30 or so.

Now turning to the condition of stability. The B.R.E.M.A. specification defines stability of Power or Integrated Amplifier as follows: "Stability is the ability of an amplifier to operate without the generation of spurious oscillations when used with a capacitive load.

The method of Test requires the amplifier to be operated under the standard conditions of measurement except as stated below.

The amplifier is first operated with a capacitor connected across the output with no other load. If the amplifier is claimed to be unconditionally stable, the test shall be made with a range of capacitor values in steps of 0.01 mfd to 0.1 mfd and in steps of 0.1 mfd to 1.0 mfd. If, however, no special claims are made for the equipment, the value of the capacitor shall be such that its reactance at 200 kc is equal to the nominal impedance of the output being used. This condition of operation simulates conditions of capacitive loading which are not likely to be exceeded in domestic installation.

With a wide-band oscilloscope connected to the output the trace shall be examined for evidence of spurious oscillation under the two conditions (1) no input to the amplifier and (2) with a continuous sine wave input signal of constant amplitude which is swept over the frequency range of 10 c/s to 70 c/s, the amplitude of this signal shall be equal to the sensitivity voltage of 1,000 c/s. If no spurious oscillation is found the amplifier shall be deemed to be stable for that particular condition of operation.

This concludes our discussion of some of the tests for evaluating the performance of an amplifier. The logical use of these tests will enable a potential purchaser or constructor to examine a piece of equipment in a way which will answer any particular question which may be in doubt.

The Author wishes to acknowledge with grateful thanks the following references which were used in the preparation of this and the preceeding article:

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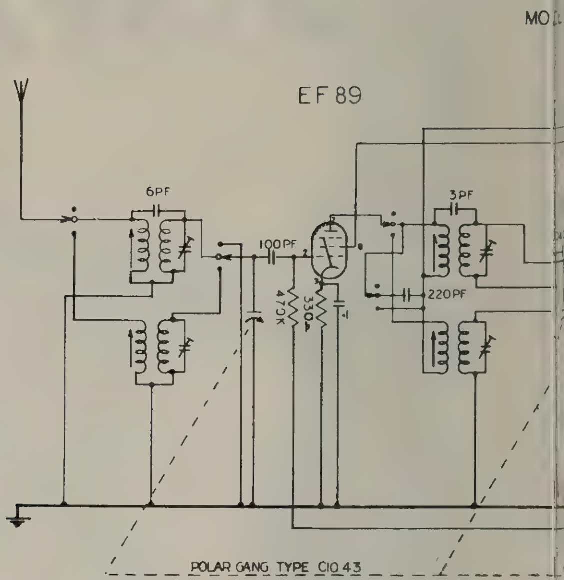

PIN NOS	1	2	3	4	5	6	7	8	9
EF89	E	0	1·6	6·3~	E	E	185	75	1·6
ECH81	75	0	2·4	6·3~	E	190	-5·5	90	-5·5
EBF89	75	0	2·6	6·3~	E	185	0	2·2	2·6
ECL86	-·4	0·5	185	6·3~	E	215	5·6	0	75

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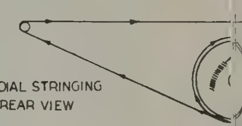

DIAL STRINGING REAR VIEW

SPIN
2 TU

EQUIPMENT REQUIRED

2 Output meters.
1 Voltmeter.
1 Non-inductive trimming tool.
1 Signal generator to cover: 455 kc/s.
600 kc/s.
1400 kc/s.
7 Mc/s.
18 Mc/s.

Set wave change switch to B/C position.

Connect output meters across speaker voice coils.

Switch on receiver and check the following voltages:

E.C.L. 86 ANODES	250 V
E.C.L. 86 SCREEN)	210 V
R.F. & I.F. STAGES)	210 V
Screen and I.F. and R.F. STAGES	85 V
Feed to triodes of E.C.L. 86	190 V

Measure voltages off station.

Check output of each channel for balance with audio signal from signal generator.

Set signal generator to 455 Kc/s and modulation to 30%.

Fully close gang.

Turn volume and treble controls to maximum positions.

Set generator to 455 Kc/s. Connect 37 ohm of signal generator output to grid of EBF 89 via a .01 MFD condensor. Connect earth lead of generator to chassis.

1. Tune top slug of second I.F. transformer for maximum output.
2. Tune the bottom slug of second I.F. transformer for maximum output.
3. Remove generator from grid of E.B.F. 89 and connect to grid of E.C.H. 81. Tune bottom slug of I.F. transformer for maximum output.
4. Tune top slug for maximum output. Repeat steps 1-4 until no change is found in the adjustment.

Remove generator from mixer grid. Remove ·01 M.F.D. condensor.

al HAMILTON

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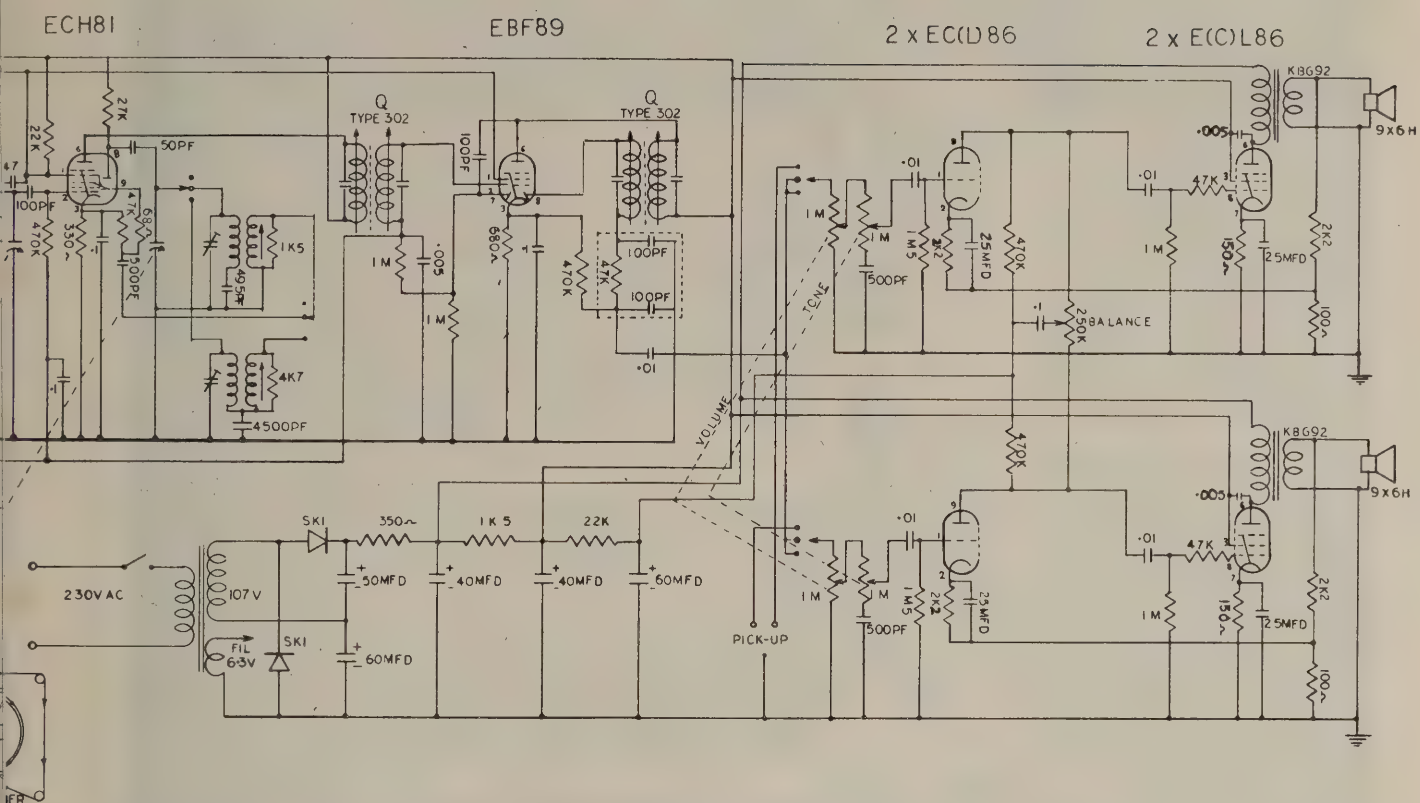

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Connect 37 ohm output of generator to aerial lead. Earth lead to chassis.

Check that pointer of receiver is set to markers on dial.

5. Set signal generator and receiver to 600 Kc/s and tune B/C oscillator coil slug to receive 600 Kc/s.
6. Tune B/C R.F. coil plug for maximum output.
7. Tune B/C aerial coil slug for maximum output.
8. Set receiver and signal generator to 1400 Kc/s and tune B/C oscillator trimmer to 1400 Kc/s.
9. Tune B/C R.F. trimmer for maximum output.
10. Tune B/C aerial trimmer for maximum output. Repeat steps 5-10 until no change is found in the adjustment.

Turn wave change switch to s/w and set signal generator and receiver to 7 Mc/s.

11. Tune s/w oscillator coil slug to 7 Mc/s.
12. Tune s/w R.F. coil slug for maximum output.
13. Tune s/w aerial coil slug for maximum output.
14. Set receiver and signal generator to 18 Mc/s and tuner s/w oscillator trimmer to 18 Mc/s.
15. Tune s/w R.F. trimmer for maximum output.
16. Tune s/w aerial trimmer for maximum output. Repeat steps 11-16 until no change is found in the adjustment.

For all adjustments keep the signal generator output no higher than necessary. To give accurate results check operation of receiver on both bands and gram.

SERVICEMAN'S COLUMN

Conducted by J. Whitley Stokes

Transistors and Television

This has got nothing to do with transistorised TV but refers to the two subjects separately.

Transistor radio servicing, more particularly as it applies to imported receivers, involves quite different techniques from that needed in valve radio (what else can you call it?) servicing.

With locally produced transistor sets, the serviceman at least has the backing of the manufacturer who is usually willing and able to provide all possible assistance, with both service information and spare parts. This is just as true whether the sets are of N.Z. design or are simply produced here under license. But with overseas models things are rather different—service information and parts are not so easily obtained. I don't doubt that many Japanese manufacturers may be quite co-operative but even so import restrictions do have their effect. Don't imagine this is the only reason for imported spare parts being hard to come by though as witnessed by the following.

I had been endeavouring to obtain a certain type of volume control from a local manufacturer of "made under license" receivers but had been advised "Out of stock awaiting further supplies now on order." After receiving the same reply twice in a period of about two months and with no indication of when stocks would be forthcoming I decided to make the inquiry direct to the sales manager who happened to be an old friend, and this is the reply I received: "We just can't get any sense out of the Japs about this matter."

So it seems a certain amount of inefficiency is not unknown even in the Land of the Cherry Blossom.

I received another setback with a high-priced supposedly high quality Japanese multimeter recently too. After less than twelve months' use the thing started to develop erratic readings on all ranges. I imagined that there was a faulty connection somewhere—there was, too—but not in the wiring, in the moving coil itself. Our old friend "green spot", but I must admit I'd never had a case in a meter coil before. After a couple of letters had been exchanged with the N.Z. agents they finally came up with the frank statement that the meter was now an obsolete model and the manufacturers were no longer able to supply replacement parts. How nice! If they were not just passing the buck, this state of affairs doesn't give me much incentive to buy Japanese products particularly as the manufacturer concerned is one of the largest and best known in the country. However, I did buy another Japanese meter but this time of a different brand and then only after making quite sure that the agents actually had a full range of spare parts in stock.

Well to get back to transistors. After seeing so much of Japanese designs it was with some interest that I was recently able to examine one of the very latest English models—it wasn't in for service either, I might add—and after having a good look at the "works" I was quite impressed. It was a quality job throughout, though, for instance it was equiped with a Goodman's speaker. As for performance, although only a 6 transistor model it knocked spots off most 8 transistor sets. I know this statement may be only a matter of opinion but I hope that at least it is an unprejudiced opinion. One thing which was not a matter of opinion though is that the receiver in question was all British in that there were no components of other than British manufacture. So what? So it's rather unusual, as there are not many English and even American manufacturers who don't use some Japanese components in their products nowadays.

And now from transistors to television. Have you ever wondered why some TV manufacturers put certain controls on the front and others on the back? As far as we in this country are concerned, I suppose it is largely a matter of following overseas practice, but even so there is still some difference of opinion amongst designers. I'm thinking of hold controls mainly—some manufacturers have always had both hold controls on the back arranged as what might be called "semi pre-set." That is, there are

please turn to page 35

A SERVICEMAN'S VIBRATOR TESTER

by J. Whitley Stokes

This unit was made to order for an Auckland firm which required a simple and easy to operate tester for bulk testing or for use by servicemen handling car radio work. Due to its simplicity it can be used by non-technical personnel.

As can be seen from the diagram the tester is basically a conventional vibrator power supply equipped with a dummy load in series with which is a 0-50mA meter. As it was designed to be used in conjunction with a battery eliminator, no provision was made in the unit itself for any metering on the input (primary) side.

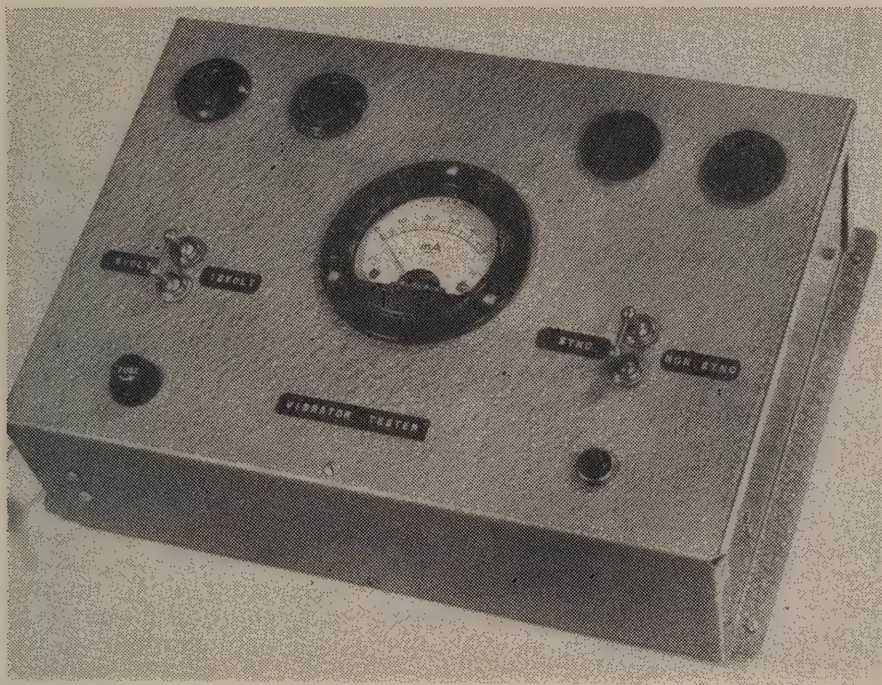
If a car battery is to be used in place of an eliminator it is recommended that a 0-16 volt voltmeter and a 0-5 ammeter be used in the battery circuit. There is room on the panel to accommodate three meters if the layout is altered accordingly. In passing it might be mentioned that the accuracy of the output reading depends on the accuracy of the input voltmeter. Do not rely too much on the built-in meters in commercial eliminators without first checking their accuracy.

The only controls are the two switches; S1 switches the input for 6 or 12 volt operation and also inserts resistors in the 6X4 heater and indicator lamp circuits, S2 switches the output circuit to accommodate synchronous or non-synchronous vibrators.

In order to simplify arrangement on the input side the two separate primary windings are permanently connected in series and "tapped down" in the 6 volt position. This results in lowered efficiency which is overcome by inserting 1 ohm equalising resistors R1, R2 when in the 12 volt position.

These resistors were each constructed by winding $6\frac{3}{4}$ inches of 1/32" x .005" Nichrome ribbon on small strips of mica approximately $1\frac{1}{2}$" x $\frac{3}{4}$" in size, and fastening the ends of the windings with Beacon rivet lugs. Resistors R3, R4 were constructed in the same manner using 16 inches and 32 inches of 31 B+S Nichrome wire respectively.

As only three different types of vibrators were to be tested, namely 4-pin, 6-pin and octal base, only three sockets have been incorporated. However, a blank socket has been provided and may be used for any other type which



is commonly encountered, e.g., the 7-pin split-reed type. The wiring has been arranged to enable vibrators with either shunt or series fed driving coils to be accommodated.

Construction

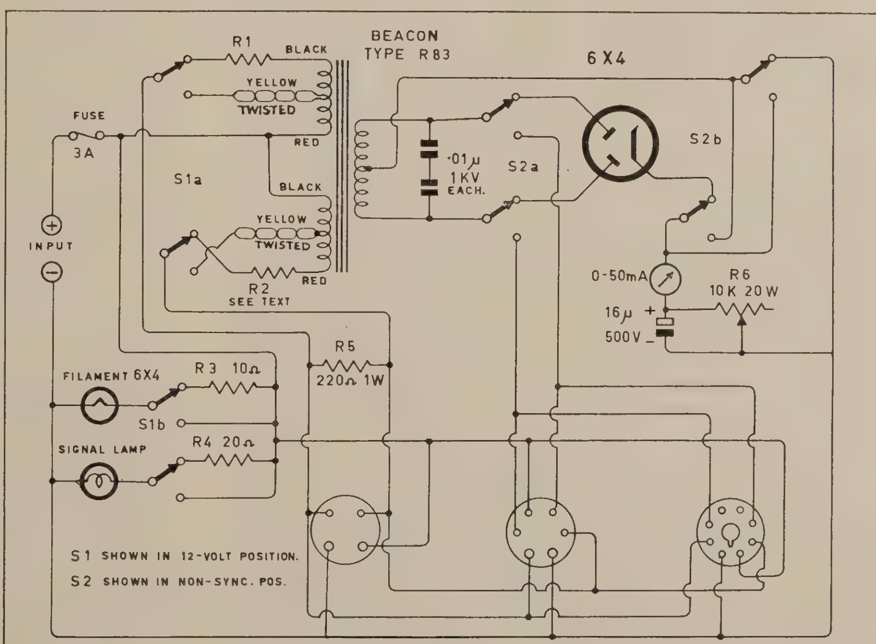
The unit was constructed on a stock size 11'' x 8'' x 3'' Birmabrite chassis, and as it was to be used flat on a counter or bench, was fitted with a bottom cover plate equipped with four rubber bumpers.

After all punching and drilling had been done the chassis was finished in hi-bake hammertone enamel which gives a hard wearing surface of pleasing appearance. The sockets used to hold the various types of vibrators were Amphenol ring-mounting type, and were selected as being the neatest and having the most professional appearance. However, their use requires the special Amphenol punch which leaves a key projecting from the edge of each hole. The writer happened to have such a punch on hand but there is no reason why flange-mounted McMurdo sockets cannot be used, as in any case they will be more readily available. Ganged toggle switches were used in preference to the rotary wafer type as it was considered that they are more positive in operation and more rugged in use.

The construction is quite straight forward and requires no special precautions. The only thing which needs a word of explanation is the ganging of the toggle switches. This is accompanied by drilling a 5/64'' hole through the knob of the toggle on each switch and then, after the switches are mounted, inserting a link pin to gang each pair. Drilling is facilitated if a small flat is first filed on the side of each toggle. As for the link pins, any convenient piece of small diameter rod will do, even a piece of galvanised baling wire. The writer used a piece of bicycle spoke! After insertion the ends should be clipped off and filed down flush, and unless they are a tight push fit it is advisable to solder over the ends to prevent any movement.

Calibration and Operation

After wiring up, the unit is calibrated with a known good vibrator as follows: The input lead is connected to the battery eliminator which is set to give a standard output of 6v. or 12v. as required, the sliding clip on R6 is then adjusted to give a reading of 35mA on the output milliammeter. Once this has been done it should require no further adjustment. In use it is only necessary to set the two toggle switches before inserting a vibrator—an instant reading will be available in the case of a synchronous type but in the case of non-synchronous types it is necessary to wait until the 6X4 warms up when the unit is first switched on from cold. A new vibrator should read close to 35mA and a reading of under 30mA is an indication of a defective or worn vibrator.



VIBRATOR TESTER.

The SHF Radio Link Comes Of Age

by

*E. W. ANDERSON**

The history of the development of SHF (3,000 to 30,000Mc/s) *microwave communication links is traced from the early experiments up to the present day. The present situation is briefly reviewed and some of the factors which will influence future developments are discussed.*

Introduction

As with many new techniques, the fundamental principles of microwave propagation were fairly well understood before any practical application was seriously attempted. The original theories of electromagnetic waves were more directly applicable to wavelengths of this order than to the longer waves which were the first to be utilised. Indeed, a number of early experiments were conducted in this part of the spectrum, the small physical dimensions and dissociation from ground-wave propagation being a considerable advantage. Unfortunately the lack of suitable sources of power prevented any convincing demonstration of their practical application.

In the 1930s, demonstrations of beyond-the-horizon propagation by Marconi, and point to point communication by Clavier, in the UHF band indicated the possibilities of this form of transmission. At about the same time the various modes of waveguide propagation were described by Carson, Southworth and others.

The demands made on the technical resources of countries involved in the Second World War interrupted much of the work on the development of microwave communications in 1939. At the same time, the efforts devoted to radar investigations fostered the technique and design of devices at higher and higher radio frequencies. Although the priorities determined by the course of the war gave radar precedence over communications in the U.K., the latter benefitted by the considerable technical effort applied to microwave technique.

Second World War Developments

The shortage of materials required for the manufacture of cables to provide military communication networks created the need for a radio system having comparable capacity to that of the carrier telephone system, greater security than that provided by VHF radio systems and with a degree of mobility.

Two main classes of valves were being developed for use in radar equipment. One, developed for radar transmitters, produced a very high peak power operating under pulse conditions. The other was a low power CW oscillator, for the receiver. Neither of these applications called for any special modulation characteristics, so that few valves were suited to the normal methods of speech modulation. Two particular types of valves were selected as potentially suitable for communication equipment; a two-cavity klystron developing 250 watts and a small split-anode magnetron developing ½ watt. Both were modified to operate at a wavelength of about 6·5 cm to avoid X and C-band radar. Neither had a linear amplitude or frequency modulation characteristic; however, two transmitters were designed using pulse modulation, the speech signals varying the mark-space ratio.

At about the same time an eight-channel multiplexing equipment was developed by allocating sequential pulses to each of the telephone channels in turn. This form of time-division multiplex with pulse-width modulation was directly applicable to both transmitters.

The high power equipment was ultimately used in 1942 for propagation tests between Aden and Berbera, a distance of 180 miles, with aerials a few feet above sea level, using surface-ducting phenomena.

The low power equipment was mounted in a trailer and was known as the British Army Wireless Set No. 10[1]. It consisted of duplicated transmitters and receivers, eight-channel multiplex channelling equipment, including telephone cable terminations and signalling units, CRT display, test unit, and duplicated petrol-alternator sets. Separate aerials for the transmitter and receiver were mounted on the roof of the vehicle. These consisited of centre-fed paraboloids connected to the equipment by means of flexible circular waveguide. The aerials could, alternatively, be mounted on 60-foot transportable towers especially designed for this purpose.

The two projects were initiated in October 1941 and the first production equipments of the low power type were delivered in January 1944. Two of these were set up between Ventnor and Beachy Head, in the south of England, for experimental purposes and switched between Ventnor and Cherbourg shortly after D-Day. This long overseas path suffered from deep fading, due to strong sea reflections, which was successfully countered by using an additional elevated aerial to provide space-diversity. The two aerials were connected to the working and standby receivers which had their AGC circuits cross-connected. The video

* The Marconi Company Limited, Chelmsford, England.

(pulse) output circuits were connected in parallel to the multiplex equipment.

With the advance in Northern Europe the link was extended eastwards, and a further Cross-Channel circuit established between Dover and Boulogne. This was ultimately extended to Luneburg, 230 miles inside Germany. This system, which was engineered by the British Signals Research and Development Establishment, may well claim to be the forerunner of the present pattern of repeatered SHF radio systems. Co-operation with the U.S. Signals Corps resulted in the production of equipment such as the AN/TRC6 (which went into service at the end of 1945). These incorporated a number of improvements which had been tried out experimentally in the U.K. but which could not be incorporated in production equipment.

The main disadvantage of the system was that all channels were reproduced at voice frequency. This provided a ready access at any station, but the telephone channels could not be extended, as a group, over conventional cable circuits, without the use of additional frequency-division multiplex equipment. This disadvantage was not serious for low capacity systems having a free use of the spectrum. In addition, pulse modulation had the distinct advantages of requiring very low orders of amplitude and phase linearity, and of tolerating intereference signals and reflections of considerable magnitude. Pulse regeneration circuits maintained a reasonable signal-to-noise ratio down to the threshold level of the receiver.

The commercial practice of increasing the capacity of cable circuits by frequency-division multiplex telephone channelling equipment was well established by the end of the war. Further expansion of existing systems was economically obtained by the addition of further cables in the same ducts, or along the same pole route. There was little incentive to accept the relatively unproven medium of radio transmission. In any case, for them to be considered seriously, it was imperative that microwave radio relay systems should accept the same form of channel grouping. Except where cable route construction presented serious difficulty, the radio-link was, therefore, not a serious competitor. Apart from a few VHF links across stretches of water, the multichannel radio system was virtually non-existent.

However, the post-war need to distribute television programmes provided a stimulus, since few cable circuits had sufficient bandwidth, and the demand for telephone circuits to accept both television and telephony signals restricted the choice to single or double sideband amplitude modulation or frequency modulation. The difficulty in achieving adequate frequency stability or amplitude linearity resulted in the general use of frequency modulation. Several frequency-modulated VHF systems had already been developed, and the translation of the signal to the higher frequency bands, by addition or multiplication processes, was limited mainly by the efficiency and power output of the final stage. Although several reasonably efficient klystron amplifiers had been produced for operation in the SHF band, they were not generally used for link transmitters. The Klystron established itself as a high power amplifier for tropospheric scatter transmitters, but for the link function the triode was used until the travelling-wave tube was developed. The travelling-wave tube not only provided adequate gain, bandwidth and power for the link application but, in alternative forms, a low noise factor and a high gain for receiver and repeater equipments.

During this period, however, klystron oscillators and allied valves were developed with reasonably linear frequency-modulation characteristics, permitting direct modulation of the transmitter valve. These led to a second class of equipment used for the transmission of multi-channel telephony and television signals. A typical example of the former was the British Army Wireless Set B70, a portable equipment produced for military use, having a capacity of twelve telephone channels (the complete transmitter - receiver, excluding the channelling equipment, weighing about 40lb. with a power consumption of 100 watts). This type of equipment has also become established as a more sophisticated system, for fixed station operation, in the 7000 Mc/s band, having about 1 watt output and a capacity of 300 to 960 telephone channels or one television channel.

The directly-modulated systems, with one or two exceptions[2], repeat the modulation-demodulation process at each repeater station, which means that the carrier frequency base band level and response, over each section, are not rigidly related. The extension of such a system over an international circuit places very exacting requirements on the individual units and on the setting-up and maintenance of the system.

With the heterodyne type of system it is usual to produce the frequency-modulated signal at a frequency of 70 Mc/s. This is added to a stable oscillation of the appropriate frequency, amplified in a TWT or triode amplifier, and radiated. At repeater stations this signal is either heterodyned to 70 Mc/s, amplified, and retranslated into the SHF band, or amplified directly by means of a TWT amplifier and re-radiated with a suitable frequency shift. The carrier frequency and baseband characteristics are then mainly determined by the terminal equipment. The performance of both types of system is dependent on the linearity of the frequency modulation and demodulation processes, and the phase-linearity of the circuits carrying the FM signal. A departure from the ideal results in inter-modulation distortion, which, together with the thermal noise inherent in any form of transmission, must be maintained to certain minimum standards.

These minimum standards having been set for the various types of communication circuits by C.C.I.F. and C.C.I.T., it was equally important to

establish comparable circuit quality over radio links. C.C.I.R. subsequently made recommendations for the essential equipment parameters and performance standards, to ensure that composite systems would integrate to provide the desired overall circuit quality. These tended to foster development along the lines of established technique rather than to promote new approaches to the general problem. Although pulse-modulated and and amplitude-modulated systems are not excluded as a solution to the problem, the emphasis is undoubtedly on FM system, as already outlined, and covers frequency bands for which equipment techniques have been established. It should not be inferred that systems apart from national trunk circuits necessarily follow the same standards; many military and specialised communication links depart radically from the pattern described.

The Present Situation

Although two decades ago the UHF and SHF bands offered a potential traffic capacity many times that already exploited for communications, it soon became apparent that, at least in the more highly developed countries, no extravagance in bandwidth could be tolerated.

The extent of the present SHF systems, and the capital investment involved, is such that whatever alternatives are available in the next decade, they will continue to function, basically, in their present form. It may be inferred that, in general, these systems can meet the present demands for communications with acceptable circuit quality, reliability and operating costs. It does not, however, preclude the possibility that demands for specialised forms of communications may not take advantage of alternative forms of propagation and modulation, or widely different frequency bands, nor does it mean that the design has reached finality. The cost of the service provided by broadband systems may be reduced by a decrease in capital and maintenance costs and/or by an increase in the capacity of the system. The former is of interest to under-developed countries, where the immediate revenue is limited, and the latter to highly developed countries, where the service may become saturated during peak periods. A reduction of cost, together with the availability of subscriber trunk dialling will, no doubt, increase the demand by private subscribers for trunk circuits.

The Future Pattern

The development of new techniques in allied fields may well indicate the trend in microwave radio relay design. Already the association of semi-conductor and miniaturisation techniques have led to more compact assemblies with greater reliability, and low power consumption.

Any innovation must be considered in terms of an equipment with an operational life of around fifteen years, forming part of a vast communication network. Although this might be expected to inculcate a conservative approach to the engineering of equipment for this purpose, the need for higher

standards of performance, and increased capacity, has resulted in the introduction of many new devices and techniques.

Of the ferrite devices, the isolator is already established as a means of absorbing reflections from waveguide components. The circulator permits the interconnection of a number of waveguides without mutual interaction. Together, the isolator and circulator provide an elegant means of connecting a number of broadband systems to a common aerial and feeder assembly.

The horn aerial, having a broader bandwidth and generally superior characteristics to the well-established paraboloid, permits simultaneous operation on several SHF communication bands and may well involve the development of further ferrite components.

Although semi-conductors have been known in rudimentary form for a very long time, and the transistor since 1948, it is the last few years that have seen the extensive application of monocrystalline solid state devices to communications. It is difficult to foresee, in some cases, which of the many variants will establish itself for a particular purpose. For example, the tunnel diode is inferior, as a receiver input amplifier, to the parametric and maser amplifier, but it is marginally better than the TWT amplifier, and is more convenient than any of these. Transistor oscillators, amplifiers and varactor multipliers enable stable carriers to be generated in the SHF band, without the use of thermionic valves. Apart from the basic broadband equipment, many of the ancillary functions may well be performed by semi-conductor devices. Their advantages over their thermionic and electromechanical counterparts include compactness, low power consumption, absence of "warm-up" time, and reliability. In addition, most require only low-voltage supplies which are easy to generate and stabilise.

It is possible that new circuit techniques made available by the use of semi-conductors may have more than a superficial influence on the broadband system. The problems which originally excluded single-sideband amplitude modulation in favour of FM were associated with carrier stability and amplitude linearity.

Although narrow-band FM systems exhibit an "FM improvement," by the utilisation of a wider bandwidth than required by an equivalent AM system, the current wideband systems carrying 1800 channels, or combined telephony and television, exhibit an appreciable degradation (because a channel deviation of 140 kc/s may be associated with a baseband frequency of up to 8024 kc/s for an 1800-channel system). A single-sideband system would provide a uniform and much higher minimum signal-to-noise ratio with considerable economy of bandwidth.

The SSB system requires a carrier stability of the order of 1 part in 10^{10}. While this may not be realisable with entirely independent simple oscillators (and they would be required whenever access to the baseband is necessary), a partially suppressed carrier or pilot transmission might achieve it.

At low frequencies, the lack of amplitude linearity is offset by the application of negative feedback. At very high frequencies, the transit time within the valve, particularly with klystrons and travelling-wave tubes, precludes the use of sufficient feedback without a serious reduction of bandwidth. Although semi-conductor devices exhibit finite transit time, it is possible that feedback techniques may be applicable.

A further advantage of the SSB system lies in the fact that once the signal has been generated, by well-established methods, it has merely to be translated to and from the SHF band. The SSB "modulator" may be designed to give a prescribed linearity, since this is mainly a function of level, whereas the FM modulator and demodulator rely on the characteristic of a valve or resonant network, neither of which may be completely defined.

The SSB signal is more tolerant of echoes, and the phase characteristic of the circuits through which it passes. Both of these considerations become increasingly important as the bandwidth of the FM system is increased.

Conclusion

Whatever new techniques are applied to SHF links, two main targets exist. The first is the further development of the networks already installed in the highly developed areas, particularly North America, Europe and Japan, to obtain maximum utilisation of the spectrum and par excellence performance. The second is to provide systems which are inexpensive, reliable and easy to maintain for countries with low national income and limited technical resources.

It has been shown repeatedly that the provision of a reliable telephone service promotes a rapid increase in the demand for circuits. At the same time, the need to distribute television programmes to provide national coverage, makes it essential for any progressive country to provide a suitable network.

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2 "Microwave Toll Systems," E. W. Anderson, Electronic Engineering, Vol. 30, No. 363, May 1958.

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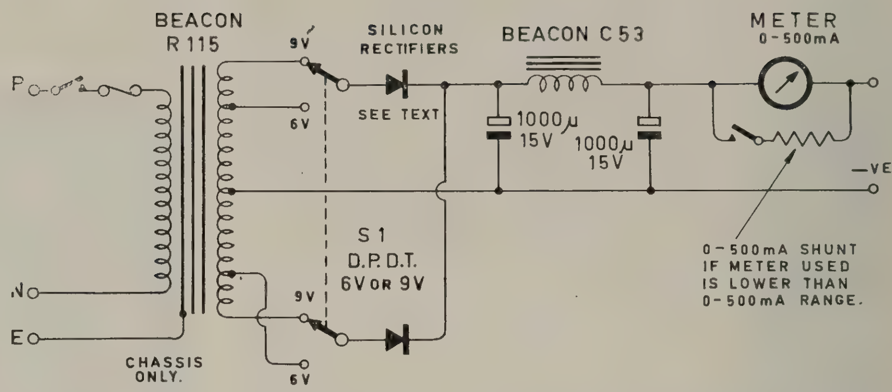
ABOUT THE AUTHOR

E. W. ANDERSON. Born in London in 1912. He was educated at Bromley County School, and graduated at London University in 1933. He joined the British Army Signals Research and Development Establishment in 1936, working on military communications. In 1941 he took charge of microwave communications development, and was responsible for the No. 10 set from inception to operation. After the Second World War he joined the Telephone Manufacturing Company, where he worked on carrier equipment. This included works with some of the first transistors to reach England from the U.S.A. He went to Canada, working on microwave communication projects for the U.S. – Canadian defence, returning to join the Communications Division of radio links. For the past three years he has been responsible for the planning of broadband microwave systems.

A USEFUL LOW VOLTAGE POWER SOURCE

By Irving Spackman ZLIMO



SIMPLE LOW VOLTAGE SUPPLY FOR TRANSISTORISED EQUIPMENT
OUTPUT 6 OR 9 VOLTS AT UP TO 500mA AND ISOLATED WITH RESPECT TO EARTH.

A Supply for Transistorised & other Hybrid Equipment

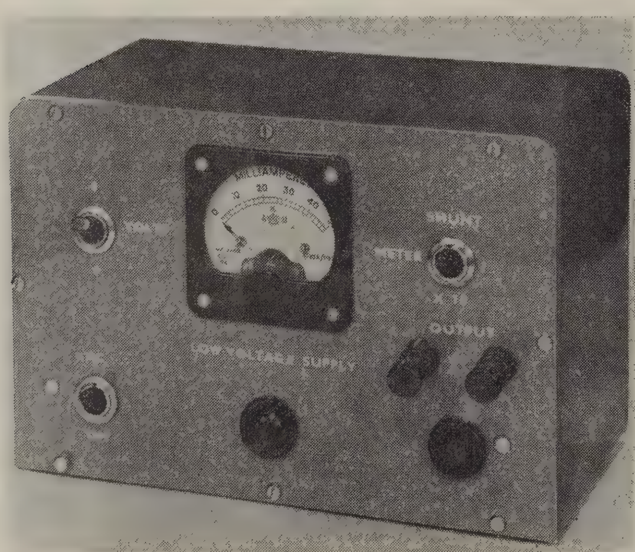
How many times have you, our readers, been in the position where, having assembled some piece of transistorised equipment, you have turned to the battery you were using previously, only to find that it is flat? It is for people such as you, in fact for all servicemen, development laboraties, and experimenters, that this power unit will prove to be one of the most useful pieces of equipment in the workshop.

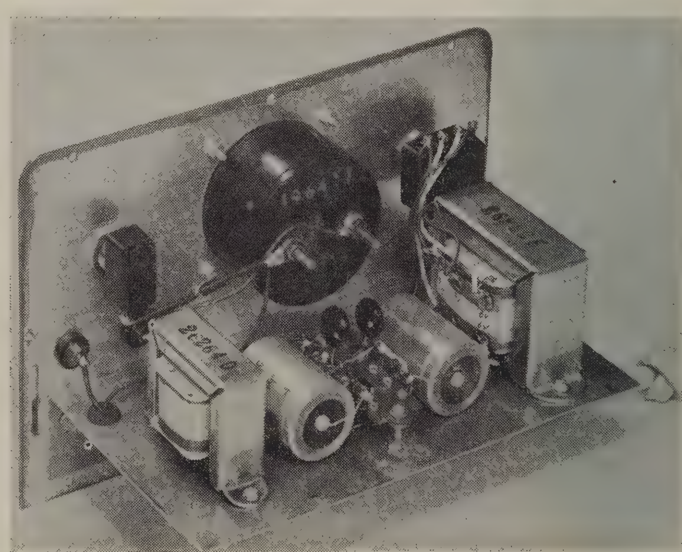
This supply will deliver, from an A.C. mains source, a low ripple, well regulated 6 or 9 volts D.C. at currents up to 500 mA. As such is adequate for powering much of the transistorised equipment such as radios, tape recorders, and portable gram units.

The unit described in the accompanying notes is built around a small transformer and choke manufactured by Beacon Radio Ltd. The transformer, Type No. R 115, has a secondary winding with 9 volts output, and also two taps on the same winding to give 6 volts output, both these voltages measured at the output of the filter under average load. The No. C 53, and two electrolytics of preferably 1000 mfds. capacity at 12 to 15 volts working voltage. Two rectifiers are used in a full wave systems, and any pair of silicon rectifiers capable of ½ ampere maximum current will serve admirably. Rectifier types suggested for this supply are R.C.A. types IN3254, IN1763, or Philips/Mullard Type OA210. (For further details regarding silicon rectifiers, see "Looking at Silicon Diodes," Sept. 1963.)

The output terminals of the supply are both isolated from the case so that either positive or negative lead can be earthed at another point. This is done mainly to avoid possible short circuit conditions occurring when test equipment is being used.

The circuit also shows a switch controlling the mains input, together with another switch selecting the 6 or 9 volt tap. The metering facility for current with its attendant 50/500 mA shunt is very useful as a check on equipment connected to the supply. To





protect the power unit as a whole and the metering equipment as well, a 500 mA fuse should be included in series with one side of the supply. Polarised terminals or connections well labelled are recommended, as reversal of voltage polarity on some transistorised equipment can destroy the equipment.

The supply is shown constructed in a small metal cabinet, with the terminals, switches, panel lamps and meter located on the front panel. The chassis is conected to the earth lead of the three-core mains lead. All the components with attached leads are mounted on a small sub-chassis at the back of the panel, whilst the condensers, rectifiers, etc., are assembled across a small insulated panel with connection tags fixed to it.

Once assembled, the unit can be tested for a suitable load. The output voltage variation from current loads of say 10 mA to 500 mA is less than ½ volt, which is adequate for most applications.

Author's footnote — Beacon Radio Ltd. advise that they now produce two models of simple power units similar to that described above, without the switching or metering facilities. These are produced for those who desire to purchase a complete unit, for a similar application or for building into other equipment.

The types are listed as follows:

M.P.1 — 6 volts 0.5A.

M.P.2 — 9 volts 0.5A.

Further enquiries regarding these units or the R 115 transformer and C53 choke should be addressed to Beacon Radio Ltd.

NATION-WIDE INSTRUMENT EXHIBITION

British Instruments "Do the Rounds"

A visit to each of the four main centres by the Dawe representatives over the past few weeks has created considerable interest in this Company's more recently introduced electronic test equipment. Concentrating on Sound measuring and Acoustic equipment some ten instruments were on show and the four available patterns of Dawe Sound Level Meters were of especial value in view of the current upsurge of interest in noise measurement and reduction. These ranged from a simple Sound Level Indicator covering the range 40 dB to 120 dB (Type No. 1408) to the type 1419A octave Band Sound Level Meter covering octaves from 125 c/s to 4Kc/s and Sound Pressures from 24dB to 140 dB in addition to A, B, or C Weighted Sound Levels according to BS 3489. To complement the Sound measuring equipment was an acoustic calibrator of the falling ball pattern (1417) suitable for quick checks of S.L.M's to ± 2dB and also shown was a Third Octave Filter (1463A) suitable for use with Dawe's Standard Sound Level Meter.

In the audio generation field three instruments were shown—the 443 Audio Sweep Oscillator, the 412 B Pulse Generator, and the 419c White Noise Generator. The latter two were of particular interest, being of the "new" Dawe styling. The measurement and band analysis of noise was adequately covered by the instruments mentioned above but further information could be obtained from the 1466A Statistical Analyser on show. This instrument, when fed from a Sound Level Meter, displays on cyclometer type dials the number of times the sound level exceeds three predetermined levels over a 20 dB interval at any point in sound levels from, say, 30 dB to 100 dB. Sampling rates from 10 a second to 1 in 10 seconds allow quite fast level rises to be recorded if need be. A total count of the number of samples taken is also available. Discussion with Mr. Len Carter, Elekon (Overseas) Limited's manager, made it clear, nevertheless, that the Statistical Analyser is not the answer to impact noise analysis. This, he said, was a kind of noise that defied simple instrumentation.

In later issues we will report in detail on several of the instruments mentioned above but, in the meantime, further information can be obtained from the agents Elekon (Overseas) Limited.

200′ Microwave Radio Mast at Tolsford Hill, England.

New Telephone and Television Links between London and France

Important new microwave links, worth about £175,000 are to be provided between London's new 600-foot Post Office Tower and Lille in Northern France. This equipment will boost the number of international telephone circuits and also provide a permanent 625-line Eurovision television link to replace the present temporary system. Shown here is the 200-foot microwave radio mast at Tolsford Hill, near Folkestone, England.

The new installation features the very latest transistorised microwave equipment suitable for up to 1800 two-way telephone circuits between the Post Office Tower, London, and the Tolsford Hill mast. Telephone circuits will be carried from there to Lille by an existing microwave link completed in 1959 and by a further new link of 600-circuit capacity. Television signals will be carried to Lille by the existing link.

Manufacturer: Standard Telephones and Cables Limited.

Serviceman's Column

Continued from page 23

knobs fitted to the shafts even though they are accessible only from the rear of the set.

On the other hand some manufacturers started off with both hold controls on the front, then made the horizontal hold a preset whilst still retaining the vertical hold on the front. The reason for this being that it was considered necessary to have the vertical hold "out front" in order that it could be readily adjusted for best interlace. However, any front control must be considered as a "user" control and the majority opinion seems to favour as few user controls as possible. So do I ! Not that all users are quite clueless when it comes to getting the best picture, but where the finer points like interlacing are concerned, they are quite beyond the average user. If the design can be arranged so that the receiver will retain interlace over long periods without adjustment so much the better for all concerned. I notice N.Z. Pye has only just recently relegated the vertical hold to the rear, being one of the last major manufacturers to do so. By comparison, a five year old English Pye I look after has both hold controls as screwdriver pre-set adjustments.

Still on the subject of controls I must admit that not only do I favour as few user adjustments as possible but also I like to see the range of such controls restricted to that which gives the minimum effect necessary to get the best picture under varying conditions. It seems to me that if the range of any control is excessive it will make it all the more likely that the user will have difficulty in securing the optimum setting. For example, it has been frequently said that the contrast control is one of the most difficult for the user to master, how much more so if its range is such that by turning to minimum it is possible to lose the picture entirely! Similarly where the range of the vertical hold control is sufficient to allow two or more complete pictures to be obtained when wrongly adjusted, many users have difficulty in recognizing this condition as being what it is, even though they may be quite capable of making adjustments to stop rolling.

Some owners request the serviceman or dealer to adjust the controls to get the best picture and state they will be left untouched apart from perhaps an adjustment of the volume. It is a nice thought that the state of the art has advanced so far that a set can be switched on day after day without needing any adjustment, but the "leave everything alone" owner is quite helpless when a visiting grandchild does a bit of knob twiddling unbeknown to him. In such cases he feels sure something has gone wrong with the set for after all how can he know what to expect if something is wrongly adjusted—he never touches anything!

LABORATORY REPORT

Kitset Component Substitution Boxes

Two small, but useful, kitsets have recently been assembled and are worthy of short comment in this column. These are the ElCO models 1120 capacitor substitution box and the R.T.M.A. resistance box. Both units are of identical size, 6½in. x 3¾in. standing 3in. high over the terminals with plastic cases and metal panels.

The capacitor box gives 18 values of capacity from 100 pf to .22 uF suitable for standard working voltages. The resistance box has 36 values available from 15 ohms to 10 megohms spread over two selector switches, one giving values up to 10K ohm and the other 15K ohm up. The low or high range is selected by a slider switch on the panel.

Assembly and wiring were straightforward but the capacitor box took longer to wire as the capacitors could not be neatly spread about the selector switch wafer due to the larger values being fairly long. The capacitor box took some 90 minutes to assemble and wire as against 60 minutes for the resistance box. Whilst we hope it is unusual, it must be reported that the resistance box was received without any resistors whatsoever—a real setback to someone wanting to make an immediate start.

The values of both resistors and capacitors are within ± 10% as specified and the resistors are 1 watt rating carbon types.

Both boxes should be most useful in the service shop, and in the laboratory where the cost of decade boxes is not warranted.

W.L.

Back Copies of "R. & E."

Periodically inquiries are received for back numbers of "Radio and Electrical." A few copies of the issues since the publication changed hands (i.e. April 1961), are available from the publishers: The Magazine Press Ltd., Lumley House, 10 High Street., Auckland. (P.O. Box 1365).

BOOK REVIEWS

The first book for review this month is entitled "**Printed and Integrated Circuitry, Materials and Processes,**" by T. D. Schlabach and D. K. Rider, both of Bell Telephone Laboratories. Published by McGraw-Hill Book Co. Inc. of New York.

One of the most recent and staggering advances in the world of semi-conductor techniques is the use of micro miniaturization, encapsulated and printed circuitry and modular construction. In this book we find all the past and current approaches to the techniques used in printing and integrated circuits.

There are four interdependent but separate sections; the first (Chapters 1 and 2) discusses the properties of various insulating "base" materials, covering the mechanical, physical, chemical, and electrical properties.

The second section, including Chapters 3 to 7, details the processes leading to a complete printed circuitry assembly. Chapter 3 is entitled "Preparation of Drawings, Layout, Artwork." Chapter 4, "Printed Wiring Board Processes," details the various methods of etching, plating, and the mechanical processes for making printed wiring, etc. Chapter 5 covers soldering, metallizing, and electrode positions. Chapter 6 is entitled "Board Fabrication Processes" and discusses topics such as shrinkage and other dimensional changes in the various types of laminates, also fabrication techniques for thermoplastics, etc.

Chapter 7 is entitled "Environmental Protection," and in this chapter we find discussion of potting and embedding processes, and materials, and encapsulating methods.

We have already mentioned Chapter 8 and therefore pass on to Chapters 9 and 10 which illustrate methods of evaluating the various materials, and processes, and the problems of packaging, that is the assembly and wiring of electronic components into packaged sub-assemblies by mechanical means.

The fourth and final block grouping, that of Chapter 11, which is written apparently by a co-author, H. J. Scagnelli, covers much of the essential information on integrated circuitry. It discusses miniaturisation and micro-miniaturisation, the formation of thin film components and systems, and the production of these devices together with their packaging into integrated circuits and systems.

There are many pages of technical references—some located at the end of each chapter—and the book concludes with an extensive appendix giving details of physical properties of materials used for printed circuit techniques. An extensive subject index rounds off a very interesting and practical text.

Our copy by courtesy of the Publishers.

—I.H.S.

ELECTROMAGNETIC THEORY AND ANTENNAS, Proceedings of a Symposium held at Copenhagen, Parts 1 and 2 (1340 pages). Pergamon Press, Oxford, 1963. £10/10/- per set (U.K.).

The two volumes cover 125 papers which were presented at Copenhagen in June, 1962, at a conference sponsored by the International Scientific Radio Union (URSI), the Technical University of Denmark, the Danish Academy of Technical Sciences and the Danish National Committee of URSI. Seventy of the papers presented are given in full and 55 as summaries only. In addition the Welcoming Address by Julien Loeb, the chairman of the International Commission VI of URSI (in French), and a survey entitled "The Scientific Achievements of L. V. Lorenz," by Mogens Pihl of the Institute of Theoretical Physics, University of Copenhagen, are included.

As the title of the volumes indicates the emphasis throughout the contributions is on theory and the mathematical treatment of the problems dealt with is of high calibre, so that only post-graduate students could benefit from most of these papers. The volumes cover recent advances in the most important parts of the field. Each major topic is introduced by an invited paper, presented by international authorities in their subject. These special contributions form the basis for the invited and contributed papers of the particular topic.

The general areas covered by the books are:

Scattering and Diffraction Theory, Anisotropic and Stratified Media, Random Media and Partial Coherence, Surface Waves, Leaky Waves and Mode Propagation, Antenna Theory and Radiating Elements, Antenna Arrays and Data Processing.

The following topics are presented in more detail:

Diffraction of Radio Waves by Several Smooth Surfaces, Unstable Transverse Modes of Drifting Charged Particles in a Plasma in a Magnetic Field, Scattering by Random Media, Backward-Wave Propagation in Non-Periodic Waveguide Structures and Application of Selective Mode Coupling in the Solution to Biconical Antennas.

It seems an impossible task for any reviewer of these two volumes to do justice to the wealth of material and the valuable methods of approach given in the presentation of the various topics. However, it is self-evident that any research worker in the field of electromagnetic theory and propagation or interested in radiation problems and modern antennae or array design must give these volumes serious consideration. It follows that both Industrial or Governmental Research Institutes working in these fields, and University Departments dealing with these topics either in teaching or research, ought to make sure to have the two books in question available in their libraries.

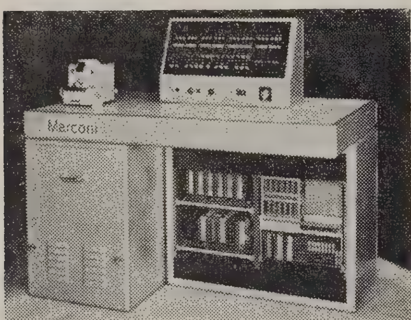
K. Kreielsheimer,
Department of Physics,
The University of Auckland.

NEW PRODUCTS: LATEST RELEASES IN ELECTRICAL AND ELECTRONIC EQUIPMENT

REVOLUTIONARY EXPERIMENTAL COMPUTER

"Over 30 Million Orders Per Minute"

The most important feature of the Marconi stand at the Instruments, Electronics and Automation Exhibition at Olympia this year was a revolutionary new ultra-high speed computer, which will form the basis of the next generation of computers to be produced by the Marconi Company. This computer, which is still at the early experimental stage, derives from air traffic control and military requirements and combines a number of advanced techniques to provide a desk-size unit which operates at ten times the speed of computers of comparable complexity currently available. It has therefore ten times the potential on-line capacity.

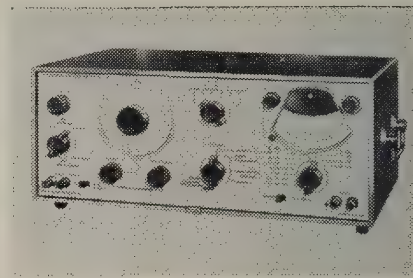


NEW DISTORTION FACTOR METER

Marconi Instruments Ltd. announce a new Distortion Factor Meter, Type TF 2331, featuring complete solid state design. Although normally powered by a.c. mains, an external battery supply can be used.

The input voltage range, for distortion measurement down to 0.05% D.F. on a direct reading meter of 0.1% full scale, is from 0.775 V up to 30 V r.m.s. The fundamental frequency rejection filter is tuned by a directly calibrated dial with fine controls so that virtually complete fundamental rejection can be obtained over a frequency range from 20 c/s to 20 kc/s.

Bandwidth for noise and distortion measurement is either 20 kc/s or 100 kc/s. Indication of distortion factor is presented on the internal voltmeter; this can also be used independently with full-scale ranges of 1 mV to 30 V and a frequency range to 100 kc/s. An l.f. cut facility eliminates mains hum and a C.C.I.F. type broadcast weighting filter enables effective noise assessment to be made. The input resistance is either a 600 Ω termination or high resistance from 10 kΩ to 100 kΩ depending upon the level. The voltmeter section has amplifier output terminals for oscilloscope examination of the residual noise and distortion or the original signal.



Used as an independent voltmeter, the input resistance is 1 MΩ.

The weight of the instrument is 15lb. It will be available in bench or rack-mounting forms.

NEW PRECISION DIE-CAST OSCILLOSCOPE

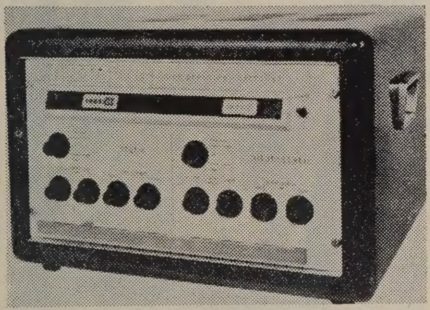
CLIFTON, N.J.—A new oscilloscope camera with the versatility and durable construction of the most expensive equipment is announced by Du Mont Laboratories, Divisions of of Fairchild Camera and Instrument Corporation. The new camera is termed the type 453, and it is also available in an "A" version (Type 453A) which includes hinging at the bezel for swingaway, and lift-off of camera for unobstructed viewing of phenomena and ease of camera placement and removal.

(Sample Electronics (N.Z.) Ltd.)

NEW PRODUCTS—*Continued*

PRECISION PRESSURE CONTROLLER FOR TESTING AIRCRAFT EQUIPMENT

Elliott-Automation's new precision pressure controller combines in one instrument the ability to carry out many essential tests on aircraft equipment. It can simulate heights, rates of change of heights, speeds and Mach numbers for testing the air-data systems and flight instruments of both present and future aircraft. It is intended for check-out on the flight line either by itself or with automatic checkout equipment, as well as for workshop and factory use. It is also valuable as an accessory for aircraft simulators and ground rigs. Listed as Type 64D 1500 and developed by the Precision Test Equipment Division, it is self-checking and will operate at large load volumes and under higher leakage rates. Pitot and static pressures can be set up either automatically or manually by simple switch controls and can then be maintained automatically by servo systems. It is equally suitable for test applications in other industries in which pressures have



to be set and maintained with a high degree of accuracy and stability. Optional extras include a remote control unit useful on flight line and pre-set pressure reference points which improve accuracy still further at the point chosen.

DESIGNERS HANDBOOK ON HIGH-VOLTAGE SILICON RECTIFIERS PUBLISHED BY WESTINGHOUSE

A 229-page handbook on high-voltage silicon rectifier characteristics, applications, and design considerations has been published for design engineers by the Semiconductor Division of the Westinghouse Electric Corporation.

A 13-page section covers design criteria for selecting high-voltage stacks and a 98-page section discusses specific applications of high-voltage silicon rectifiers. Other sections dealing with corona, reliability, terminology, and high-voltage assembly ratings and device specifications are included.

Copies of this Handbook can be obtained at cost by ordering from the Sales Promotion and Advertising Division, Westinghouse Electric International Company, 200 Park Avenue, New York, N.Y., U.S.A.

SEMICONDUCTOR CONTROLS FOR STANDARD A.C. INDUCTION MOTORS

An A.C. variable frequency drive taking power from semi-conductor static control equipment has been produced by the Control Gear Division of English Electric and is believed to be the first of its kind.

It has been fitted to a machine tool at the Central Electricity Generating Board's research laboratories at Berkeley, Gloucestershire, where it is providing a 20:1 speed range on cutterhead and feed mechanisms with its speed holding characteristic comparable with any conventional variable speed drive.

Hitherto most electrical variable speed drives have had to use a D.C. motor, with the disadvantages of maintenance on commutators and brush gear and the difficulty of making flameproof versions. This newly developed drive uses a standard A.C. squirrel cage motor, which is by far the most commonly used motor in industry, having the advantages of being simple, robust, cheap, almost maintenance free, and easily produced in a flameproof enclosure.

The control system, which is essentially static and has no moving parts, uses thyristors. (The new internationally adopted name for the silicon controlled rectifier).

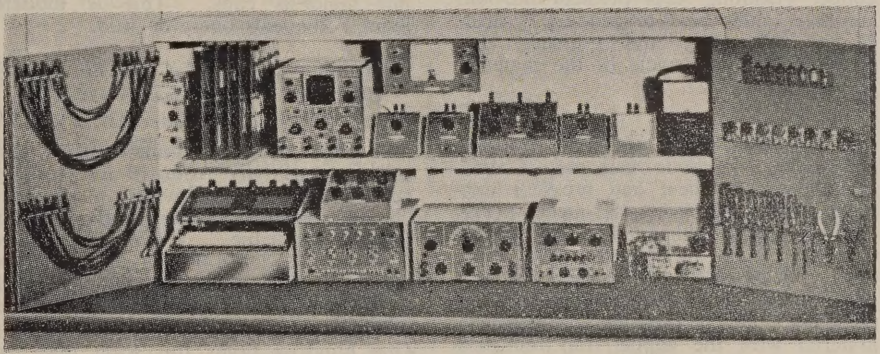
This form of control is at present costly for the lower horsepower ratings because of the high cost of the semiconductor devices but there are application requirements which can justify the use of the system, especially industrial or flameproof drives in the paper, rubber, chemical, petroleum, plastics, artificial fibre, and cable industries. The system can thus be used in a scheme where the operation of several motors has to be synchronised or the environment with moving parts.

At higher horsepower ratings these drives are much more attractive and are rapidly becoming comparable in cost to other forms of variable speed drives and as the control equipment is static there is far less maintenance than on equipment than on equipment with moving parts.

NEW ELECTRONIC SORTER TO SPEED AUSTRALIAN MAIL

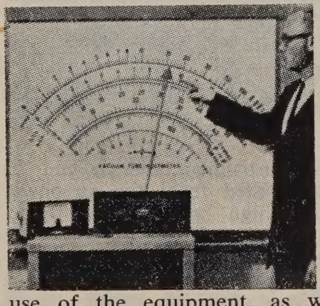
A new electronic sorting system capable of handling over 200,000 letters an hour is being developed and built by Telephone and Electrical Industries Pty. Limited, a major Australian telecommunications company operating within the Plessey Group.

The system incorporates a magnetic memory drum store and is claimed to be one of the most advanced of its kind in the world. It will be installed in the Australian General Post Office's new Mail Exchange which is at present under construction at Redfern, near Sydney.



MALMSTADT - ENKE INSTRUMENTATION LABORATORY

This laboratory was designed by Heathkit in conjunction with Messrs. Malmstadt and Enke and is intended for the use of those Scientists whose daily work brings them into contact with Electronics and electronic instruments, but who are not qualified in the electronics field.



It is hoped that by devoting a short amount of time to experiments with the laboratory these people will gain a good basic knowledge of electronics and so enable them to make better use of the equipment they use in their daily work.

The laboratory is also intended as the nucleus of an electronic laboratory for the teaching of science in schools, colleges, universities and for private use in technician training.

In addition there is a book which comes as part of the laboratory, but can also be bought separately, containing complete instructions for the use of the equipment, as well as experiments, lectures, questions and answers, making it equally suitable for private or classroom instruction.

All connections can be made with special **solderless terminals** so that the equipment may be used over and over again.

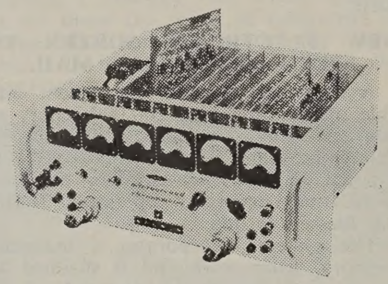
Full details are available from P. H. Rothschild & Co. Ltd., Lower Hutt. (See page 8.)

NEW PRODUCTS—*Continued*

IMPROVED COPPER-CLAD PLASTIC LAMINATE FOR "PRESSED IN" PRINTED CIRCUITS

FORMICA copper-clad laminate, grade JCC 22 has greater resistance to plating solutions and a higher foil-to-laminate bond strength than its predecessor DCC 22

A new grade of Formica copper-clad industrial laminate for "pressed in" printed circuits is used in applications where a moving contact will be required to pass over the surface of the conductor.



It replaces industrial grade DCC 22 and is received by the customer in a semi-cured state. After the circuit has been etched out from the copper cladding, it is pressed into the laminate under heat to produce a flush circuit. The heat and pressure also complete the cure cycle of the material known as JCC 22.

The new laminate is made from sheets of bleached Kraft paper impregnated with a phenolic resin before being consolidated by heat and pressure into homogeneous boards 48 inches (122 cm) long by 36 inches (91 cm) wide and 0.031-0.5 inch (0.79 mm-12.7 mm) thick. It is clad with copper foil approximately 0.0014 inch (0.0355 mm) in thickness. When fully cured, the base material with the copper foil removed exhibits mechanical and electrical properties which meet all the requirements of BSS 1137 Type 1.

Fig. 1: Shows a Micro Second Chronometer by Rank-Cintel Ltd. This includes a number of printed circuits on Formica DCC 20 grade of copper clad laminate which can be interchanged simply, as shown, by pulling them out by hand.

INDUSTRIAL AND POWER TUBES TECHNICAL GUIDE PUBLISHED BY WESTINGHOUSE

A 28-page Industrial and Power Tubes Technical Guide has been published by the Westinghouse Electronic Tube Division. It presents detailed information on application and technical specifications for industrial and special purpose tubes. An eight-page direct interchangeability list for industrial, transmitting and special purpose tubes is also included.

Copies can be obtained at cost from the Sales Promotion and Advertising Division, Westinghouse Electric International Company, 200 Park Avenue, New York, N.Y., U.S.A.

* * *

EDAC has much pleasure in announcing that Digital Measurements Limited of the United Kingdom have appointed them as their sole representatives in New Zealand.

This outstanding British company has long been noted for the high quality and reliability of their instruments and systems, and the instrument illustrated above is a fine example from their range.

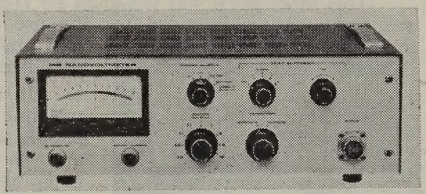
Amongst their many products, we must particularly mention their range of superb Digital Voltmeters which with their Optical Shaft Encoders, Solenoid Operated Electric Typewriter and 6 decade and 7 decade Low Level Scanners, can be used in module form to construct high quality data Logging Systems.

TV TAXI IN CHICAGO

Chicago—Taxi cabs in this city are offering passengers an extra added attraction. Sony Micro TV sets have been installed in the back seat of about one hundred cabs. "This is modern living," the cab operator said.

NEW DC NANOVOLTMETER MEASURES 10 NANOVOLTS (10-8 V) FULL SCALE TO 100 MILLIVOLTS

A new dc nanovoltmeter that features a sensitivity from 10 nv (10-8 v) full scale to 100 millivolts in 18 overlapping ranges is announced by Keithley Instruments Inc., Cleveland, Ohio. Keithley Model 148 measures and/or amplifies very small dc voltages and, by means of a zero-suppression feature, measures small changes in dc voltages. One hundred times full scale may be suppressed.



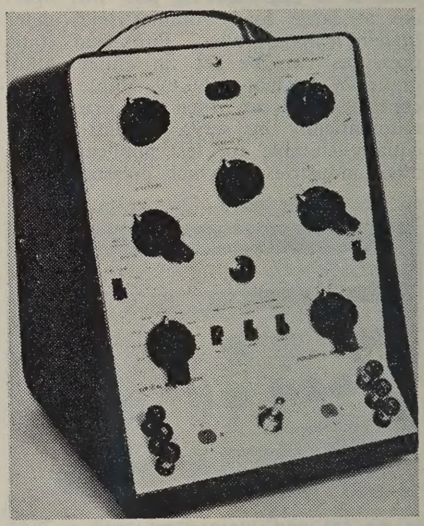
The new instrument, which can be completely isolated from the ac power line, features high line-frequency rejection, an accuracy of 2% of full scale on all ranges, and higher input resistance and faster response time than a galvanometer system. It has a ±1 volt dc, 1 milliampere output to drive other instruments; accuracy at output is 1% of full scale.

The model 148 may be used for: Measuring small temperature differences, mall-effect studies, measuring contact potentials, making Bolometer measurements, and also as a null detector for bridges and so on.

(Sample Electronics (N.Z.) Ltd.)

NEW CARIBBEAN COMMUNICATIONS SCHEME

Marconi's have received instructions from Cable and Wireless Ltd. to proceed with the supply of equipment for a major multi-channel tropospheric scatter and microwave link system connecting the Windward and Leeward Islands in the Eastern Caribbean and providing greatly improved telephone communications within the Eastern Caribbean and ultimately to the Commonwealth and to the rest of the world.



TRANSISTOR CURVE TRACER

Characteristics of transistors, silicon-controlled rectifiers, diodes and tunnel diodes can be tested and displayed by a transistor curve tracer introduced by an English company. Designed by the company's Radar and Communication Instruments Division to be used with general-purpose oscilloscopes, it provides information in a convenient form for circuit designers and for instructional purposes. It is particularly suitable for on-line testing applications in the production of semi-conductor components and in the manufacture of equipment incorporating these devices. Even unskilled operators can select matched pairs of components easily and quickly. It contains the necessary supplies and wave form generators to generate equal steps of voltage or current to the input of the device under test and to sweep the collector voltage on each step of input signal. The instrument is small and easily carried. the size being 10 x 9 x 7 inches and weight 15lb. Price is slightly over £100. The size and cost of the display required can be chosen to suit the application.

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